

## Technology Innovation from a History of Energy Crises



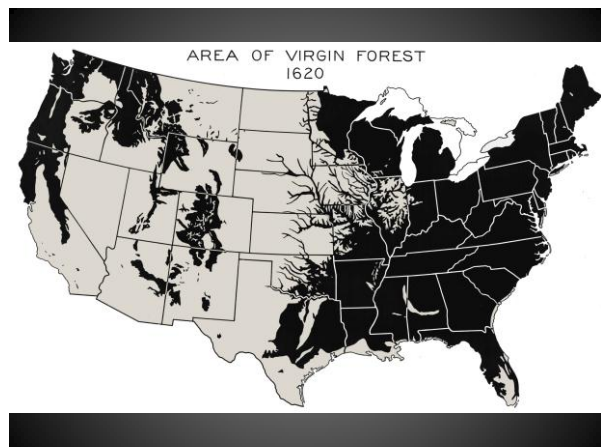
Revolutions in Science and Technology Paradigms  
*EIU Technology & Science Symposium*  
 2013

## Energy “Crisis!”

- (*n*) a time of intense difficulty, trouble, or danger
- ... not exactly what popular new sources report.
- *Energy Crisis*: A change in the status quo of energy markets related to accessibility, cost, and/or willingness to pay

## History of North American (US) Energy Crises

- Early pre-Colombian humans used many forms of biomass for fires:
  - Wood, grass, “buffalo chips”
- After the European settlers’ arrival, similar forms were used.
  - However, metal tools were introduced



## Tools



## First Neo-American Energy Crisis

- By 1637, colonies were experiencing fuelwood shortages (Schobert, 2002).
- Forest coverage was there, but inaccessible
- Forest clearing at the time was “relatively little” (Clawson, 1978)



## Accessibility Issues

- Infrastructure for ground transportation was miniscule
- Equipment could not tackle large timber
  - All the small timber that could be hauled by mule/horse teams through dense forest is used



## Accessibility

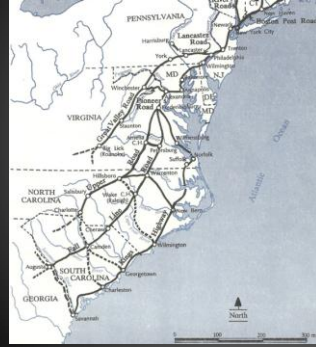
- Mid-1700s, large cities (Boston, Philadelphia, New York) necessitated wood be delivered
- In 1741, the prices of cordwood quadrupled because the rate of demand exceeded the supply (Trefil, 1994)
- In 1800, 60% of the commercial wood used in the US was for fuel (Sedjo, 1991)

## Accessibility

- Scarcity of fuelwood in a New England town in mid-1700s led to legislation creating a crew of men to patrol the beach to keep people from neighboring towns from taking the driftwood.



## Transportation



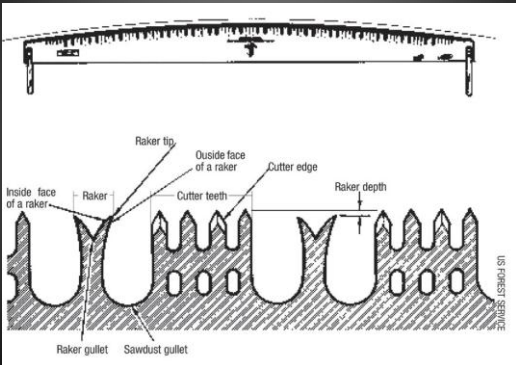
## Transportation



## Equipment



### Equipment



### Efficiency Issues

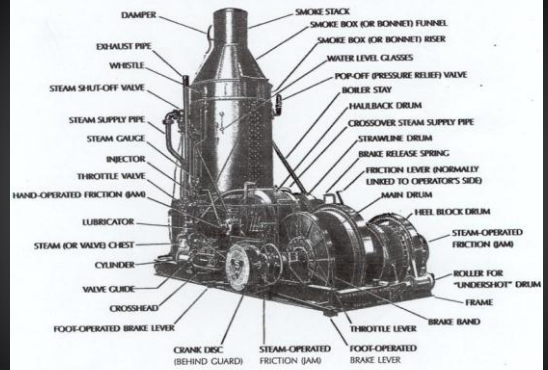
- Most fireplaces on homes were on the outside walls.
  - Disperses heat to the outside
  - Pulls cold air in



### Franklin Stove/Wood Stove



### THE ANATOMY OF A STEAM DONKEY

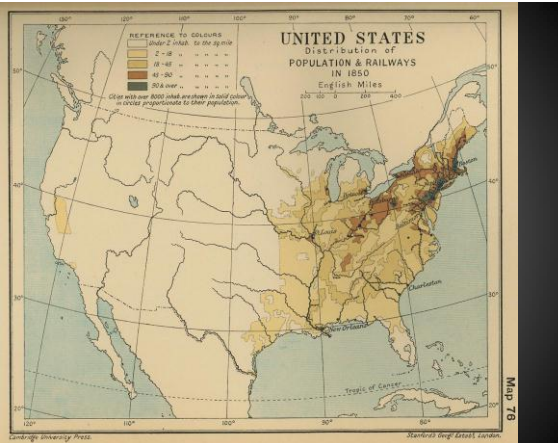
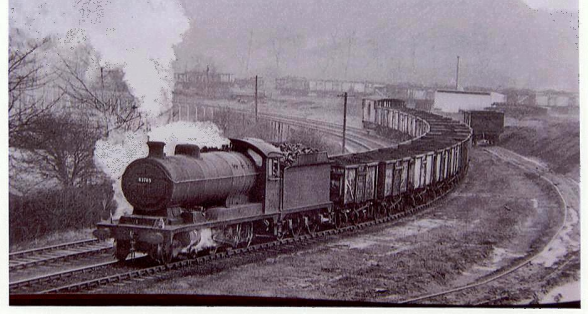


ANATOMY OF A STEAM DONKEY.

### Coal

- Coal had to be shipped from Europe and England
- Exploration began around the War of 1812
- Near 1850, coal began to replace wood for residential and industrial use in US
- Of the commercial wood in the US, 50% was used for fuelwood (Williams, 1987)

### Transportation



### Coal Furnace



## Coal Gasification

- Since coal was so dirty, a coal gasification system was developed in the 1800s to make a cleaner burning coal (Lang, 1978)



## New Crises

- World War I
  - Automotive fuel rationing
  - Focus on ethanol and biodiesel production
- Depression
  - Development of more energy efficient boilers relying on wood fuels (Gladden, 1931)

## New Crises

- World War II
  - Further rationing of fuel
  - USDA pushes public to use biomass fuels instead of fossil fuels (Sweet, Miller, & Donny, 1943)
  - Further use of gasification technology for vehicle transportation (Lang, 1978)
  - Exploration of solar photovoltaics for energy

## Gasifier Car



## New Crises

- Oil embargo and related energy crises of the late 1970s renewed interest of biomass based fuels
  - One report states that the rate of biomass energy related publications had increased 12 times in 6 years (Hitchcock and McDonnel, 1979)

## New Crises

- Executive orders for new energy sources and exploration (Exec Order 13134, 1999; Exec Order 13212, 2001)
- Billion Ton Study, 2005
- 30 by 30 Feasibility Assessment, 2007

## Next Steps

- Innovation has been sparked by needs
  - Basic needs: food, shelter, warmth
  - Wars: kill and not be killed
  - Space Race: national pride (war)
- Now what?

## Next Step

- 1960s race to the moon
- Now... Race for the Sun.
  - Plants are stored solar energy
  - Wind is created by the sun
  - Solar heat energy
  - Solar light energy

## Next Step

- Distributed energy
- Energy independence



## References

- Clawson, M. (1979). Forests in the long sweep of American history. *Science*, 204(15), 1168-1174.  
Exec. Order No. 13134, 64 FR 44,639 (1999).  
Exec. Order No. 13212, 66 FR 28,357 (2001).
- Foust, T. D., Wooley, R., Sheehan, J., Wallace, K., Ibsen, D., Dayton, D. et al. (2007). *A national laboratory market and technology assessment of the 30 x 30 scenario*, (NREL/TP-510-40942).
- Gladden, C. S. (1931). Boiler settings for burning refuse wood. *Transactions of the ASME: Fuels and Steam Power*, 55(3), 13-33.
- Hitchcock, H. C. III & McDonnell, J. P. (1979, July). *Biomass measurement: A synthesis of the literature*. Paper presented at the Forest Inventory Workshop, SAF-IUFRO, Fort Collins, CO.
- Lang, R. (1978). *Feasibility study: Commercial biomass gasifier at State Central Heating and Cooling Plant*, (California State Energy Commission, P500-78-013).
- Perlack, R.D., Erbach, D.C., Wright, L.L., Turhollow, A.F., & Graham, R.L. (2005). *Biomass as feedstock for a bioenergy and bioproducts industry: The technical feasibility of a billion-ton annual supply*. Tennessee: Oak Ridge National Laboratories. (NTRS No. PB2005-108232).
- Schober, H. H. (2002). *Energy and society: an introduction*. New York: Taylor and Francis.
- Trefil, J. (1994). *A scientist in the city*. New York: Doubleday.
- Williams, M. (1987). Industrial impacts of the forests of the United States 1860-1920. *Journal of Forest History*, 31(3), 108-121.