An U.S and global perspective on None-Depletable Energy Resources

Since forever, humankind has always relied on some sort of energy source in other to practice its activity and live a more comfortable life. Fossil fuels like natural gas, coal or petroleum have been and continue to be relatively good options in a word where the energetic demand is ever growing. However, today we are facing a major threat, which is the global warming, caused by the carbon dioxide emissions involved when these fossil fuels. In order to preserve itself, and Life in general on Earth, humankind has to find new alternatives. It is in such a context that "renewable energies" are emerging in our societies.

Solar: History of use…

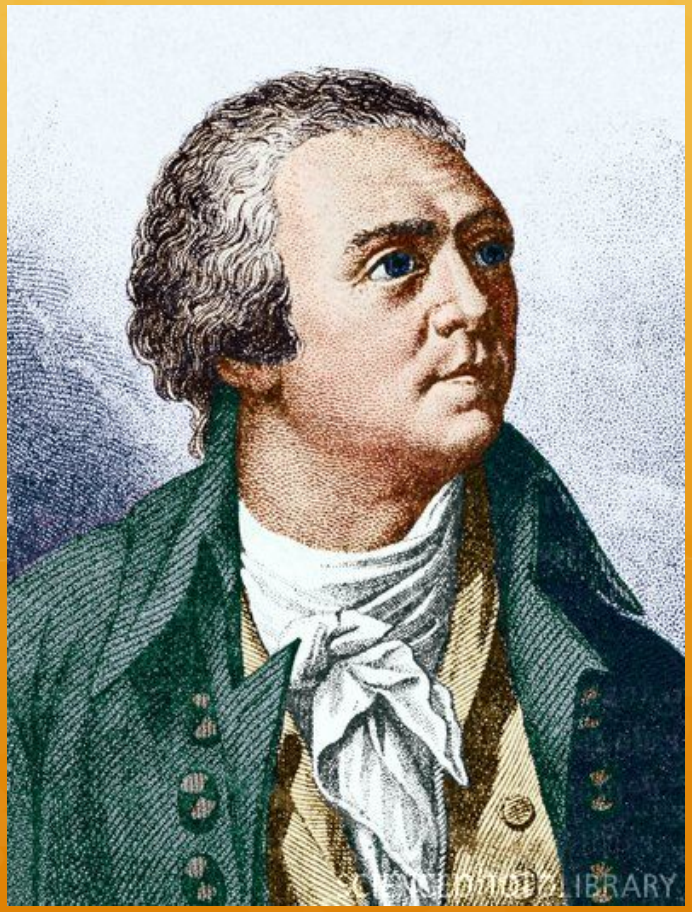
- When did we start using solar energy??

Key dates…

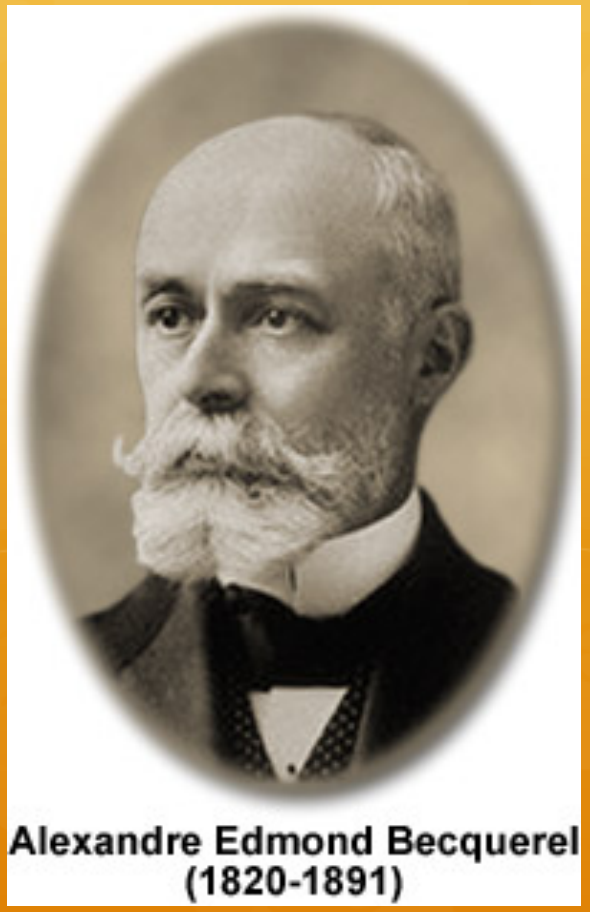
- *7th century B.C : magnifying glasses were used to concentrate sun's ray to make fire and burn ants.*

1st to 4th century A.D: romans used solar bathhouse

1767:Swiss scientist Horace de Saussure was credited with building the world's first solar collector

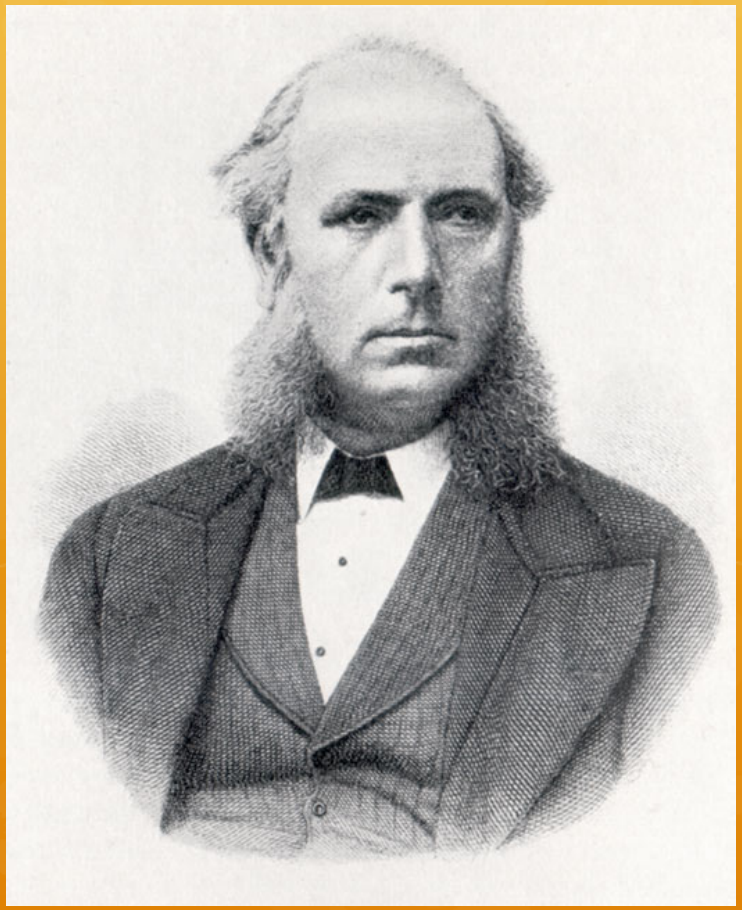


1839: French scientist Edmond Becquerel discovers the photovoltaic effect

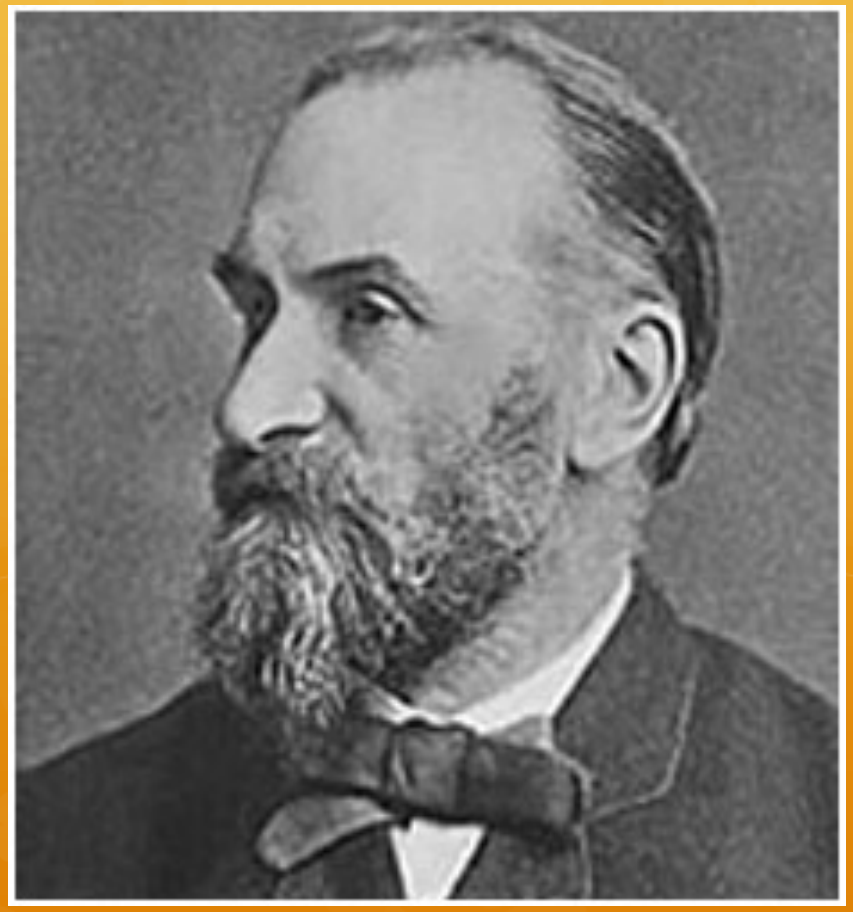


Alexandre Edmond Becquerel
(1820-1891)

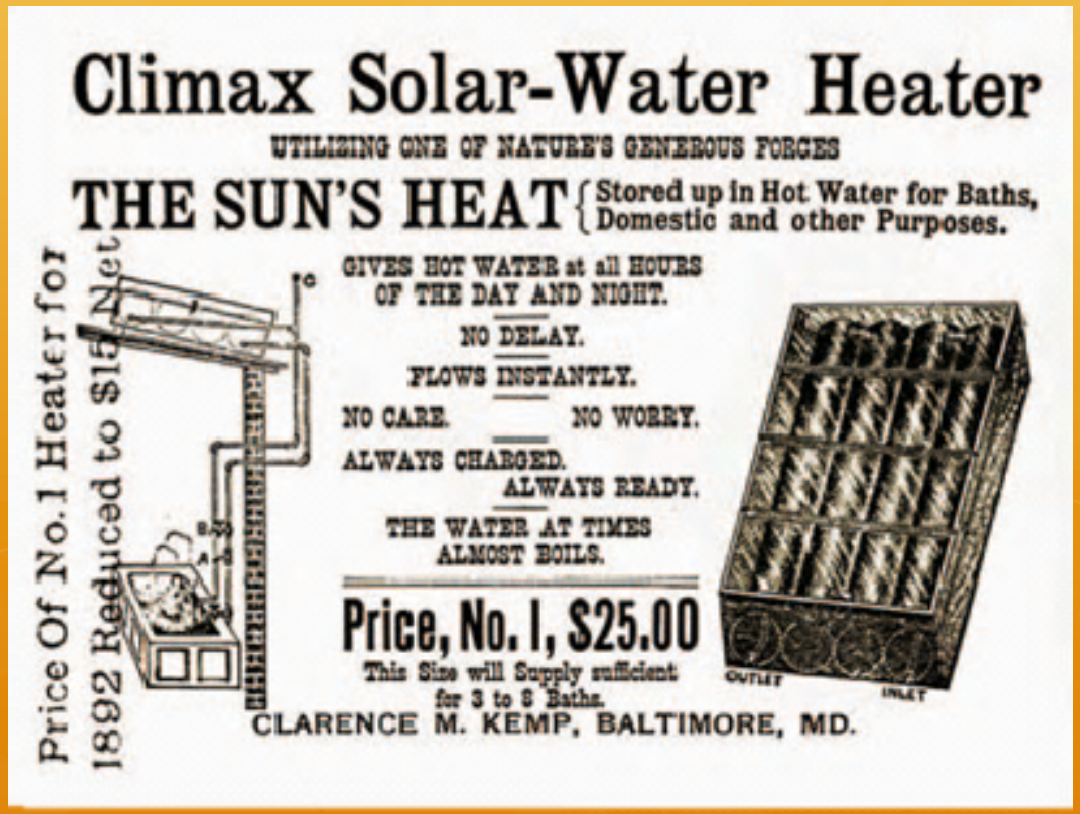
1873: Willoughby Smith discovered the photoconductivity of selenium



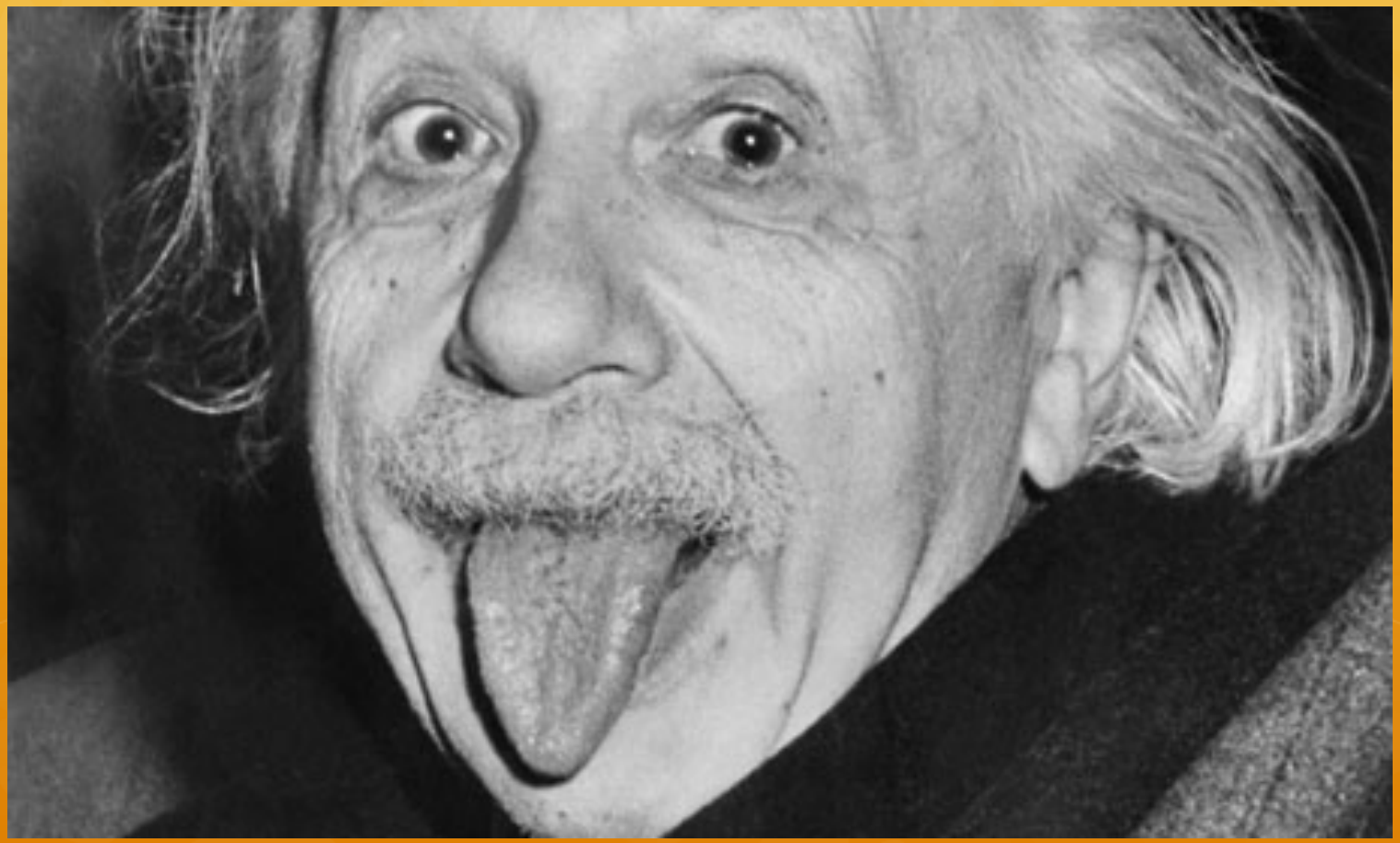
1876: William Grylls Adams and Richard Evans Day discover that selenium produces electricity when exposed to light



1891 Baltimore inventor Clarence Kemp patented the first commercial solar water heater.



1921: Albert Einstein wins the Nobel Prize for his theories (1904 research and technical paper) explaining the photoelectric effect.

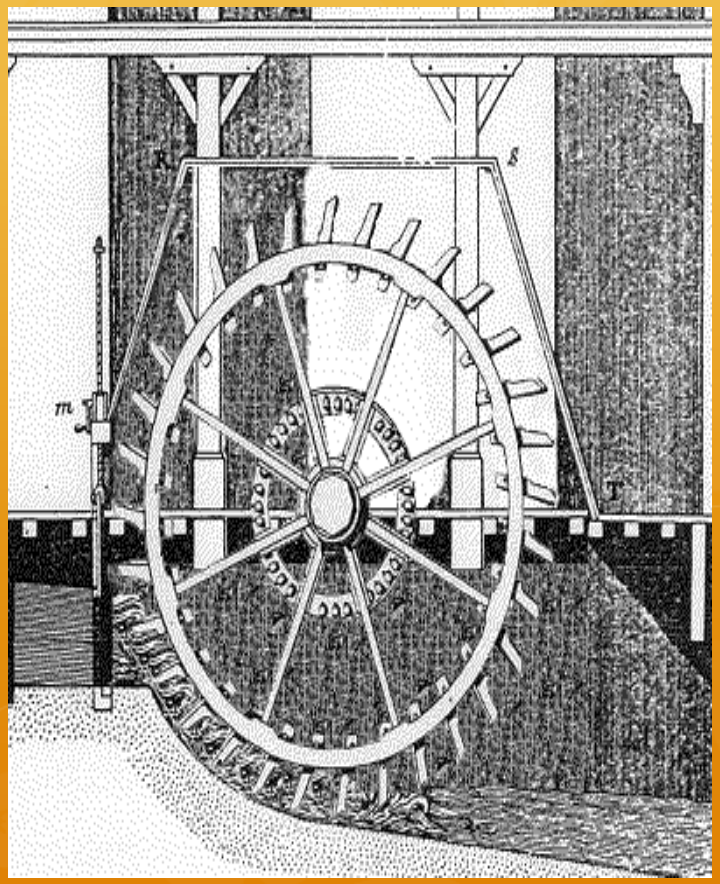


1954:Photovoltaic technology is born in the United States when Daryl Chapin, Calvin Fuller, and Gerald Pearson develop the silicon photovoltaic (PV) cell at Bell Labs

- 1996: The world's most advanced solar-powered airplane, the Icare, flew over Germany.

- 2001 Powerlight Corporation installs the largest rooftop solar power system in the United States—a 1.18 megawatt system—at the Santa Rita Jail in Dublin, California

Hydropower: history of use…



- Humans have been harnessing the power of water for over thousand of years now.
- The availability of cheap slave and animal labour, however, restricted its widespread application until about the 12th century.
- Modern large-scale water-power owes its development to the British civil engineer John Smeaton, who first built large waterwheels out of cast iron.
- Water-power played an important part in the Industrial Revolution.
- Waterpower will reborn in 1880 with the earliest hydroelectric plant being constructed in Cragside, Northumberland, England

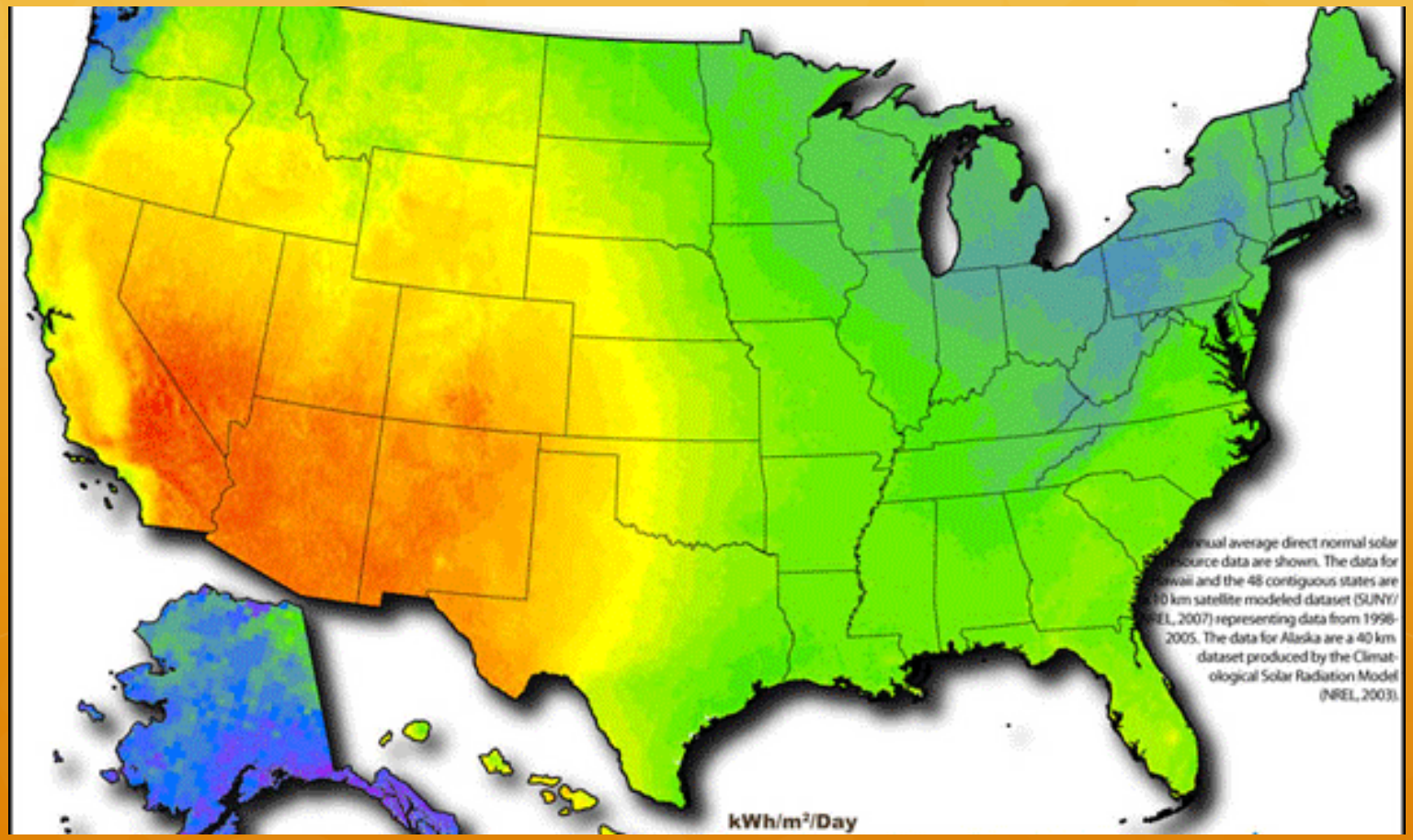
How Solar Photovoltaic panel work?

- https://www.youtube.com/watch?v=8gFwKytVw1o

How Hydropower stations work?

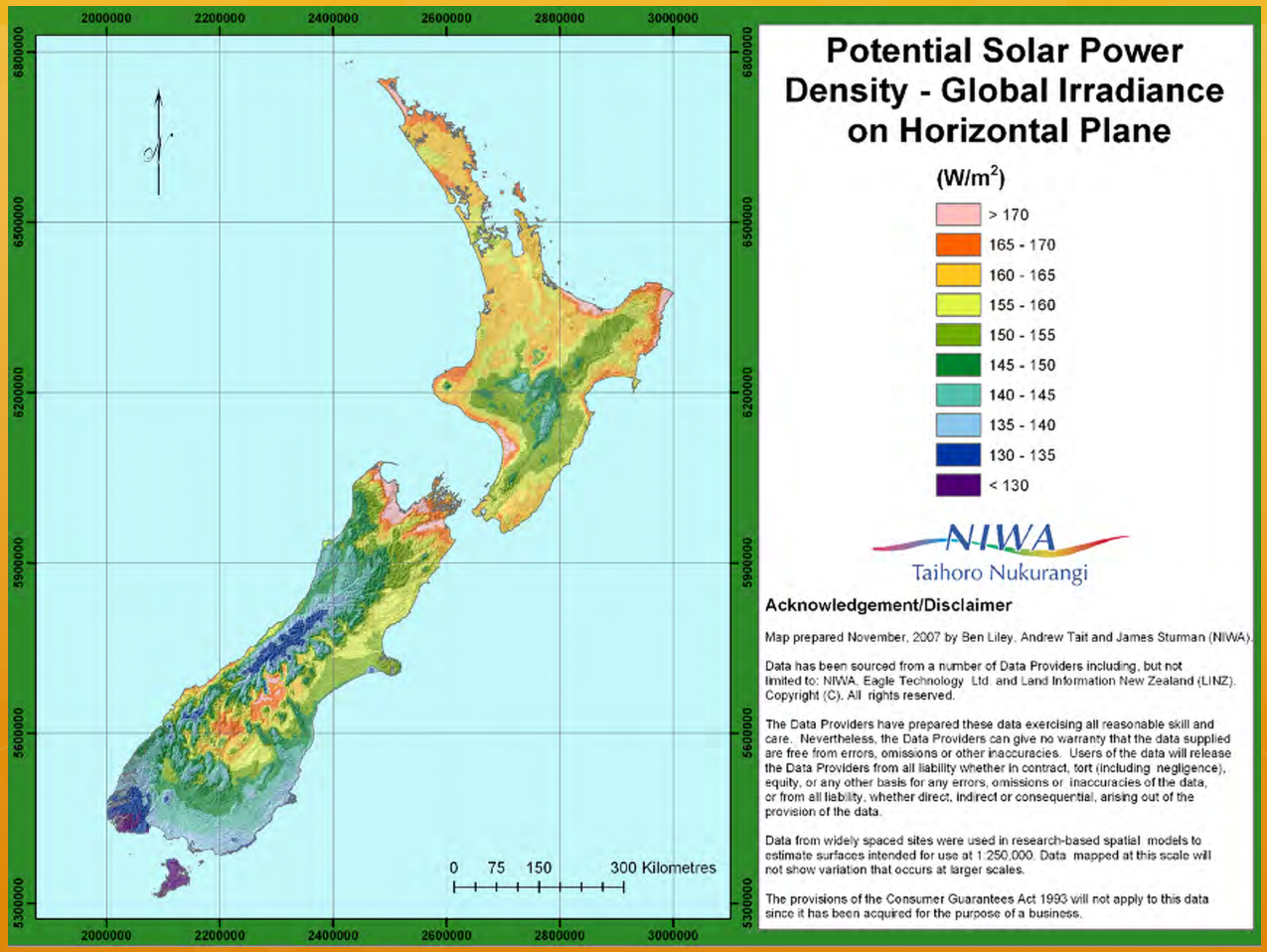
- https://www.youtube.com/watch?v=cEL7yc8R42k

Solar in The USA

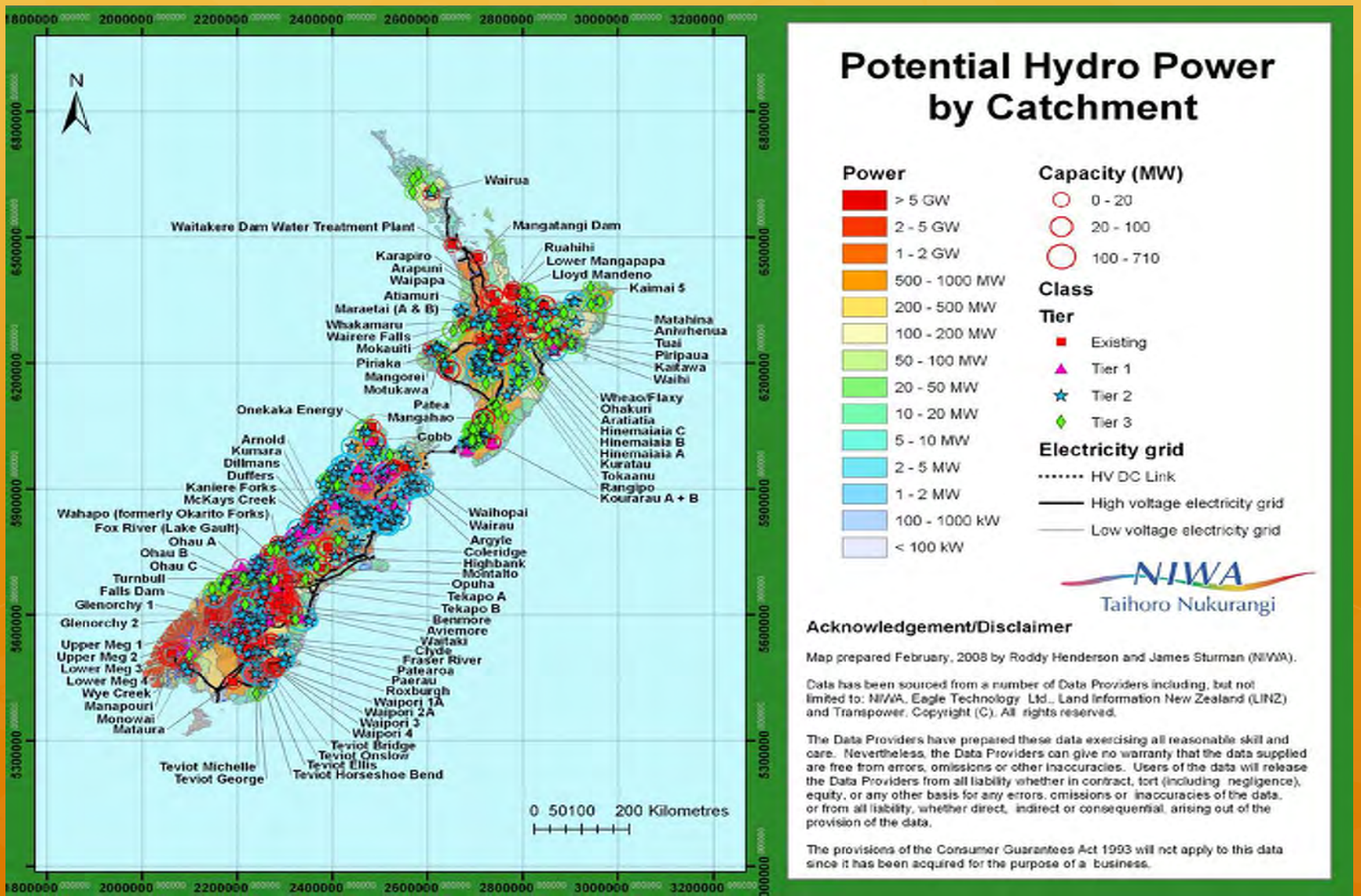


Hydropower in the USA

Solar in New Zealand



Hydropower in New Zealand



Potential Hydro Power by Catchment

Power

- > 5 GW
- 2 - 5 GW
- 1 - 2 GW
- 500 - 1000 MW
- 200 - 500 MW
- 100 - 200 MW
- 50 - 100 MW
- 20 - 50 MW
- 10 - 20 MW
- 5 - 10 MW
- 2 - 5 MW
- 1 - 2 MW
- 100 - 1000 kW
- < 100 kW

Capacity (MW)

- 0 - 20
- 20 - 100
- 100 - 710

Class

Tier

- Existing
- Tier 1
- Tier 2
- Tier 3

Electricity grid

- HV DC Link
- High voltage electricity grid
- Low voltage electricity grid

NIWA
Taihoro Nukurangi

Acknowledgement/Disclaimer

Map prepared February, 2008 by Roddy Henderson and James Sturman (NIWA).

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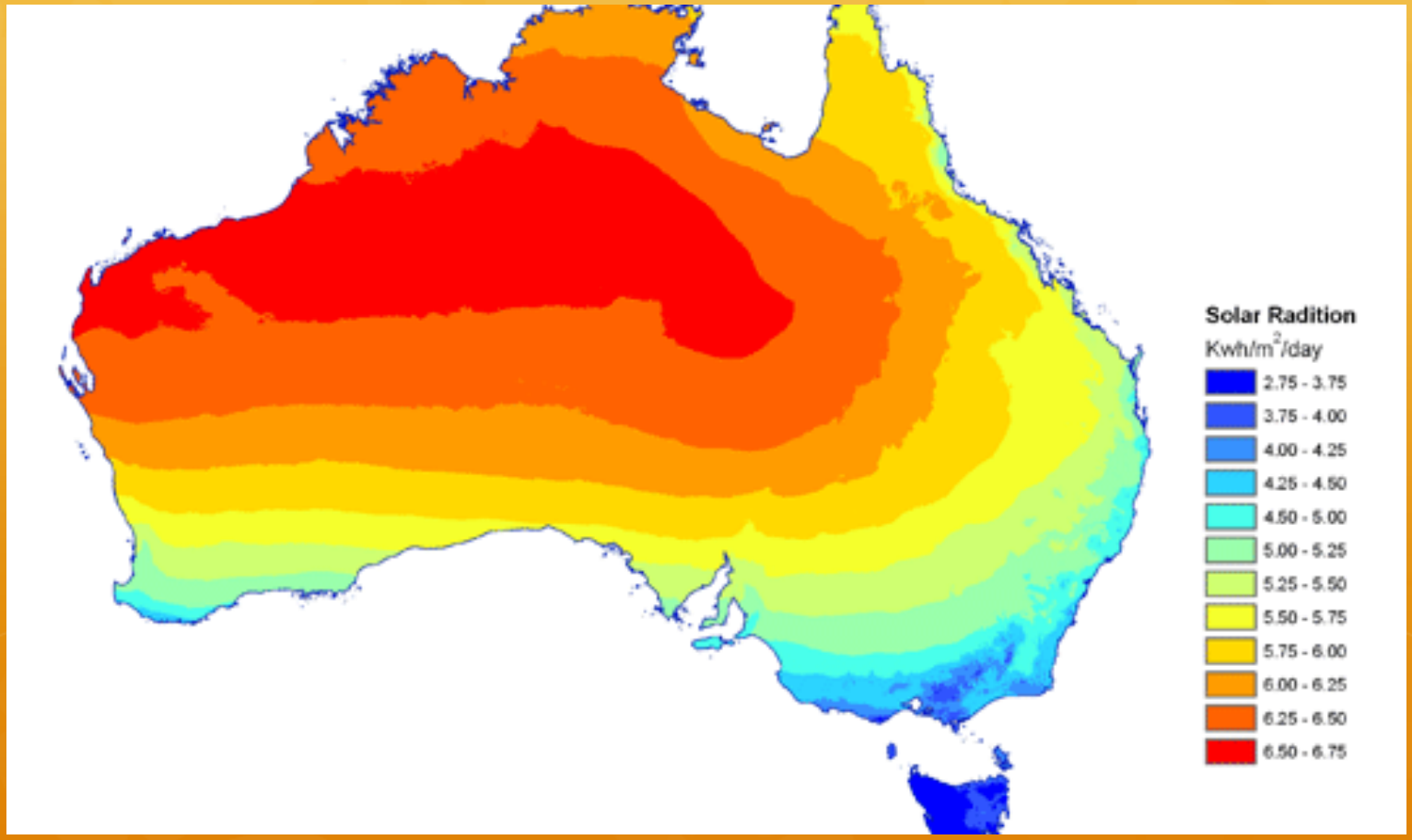
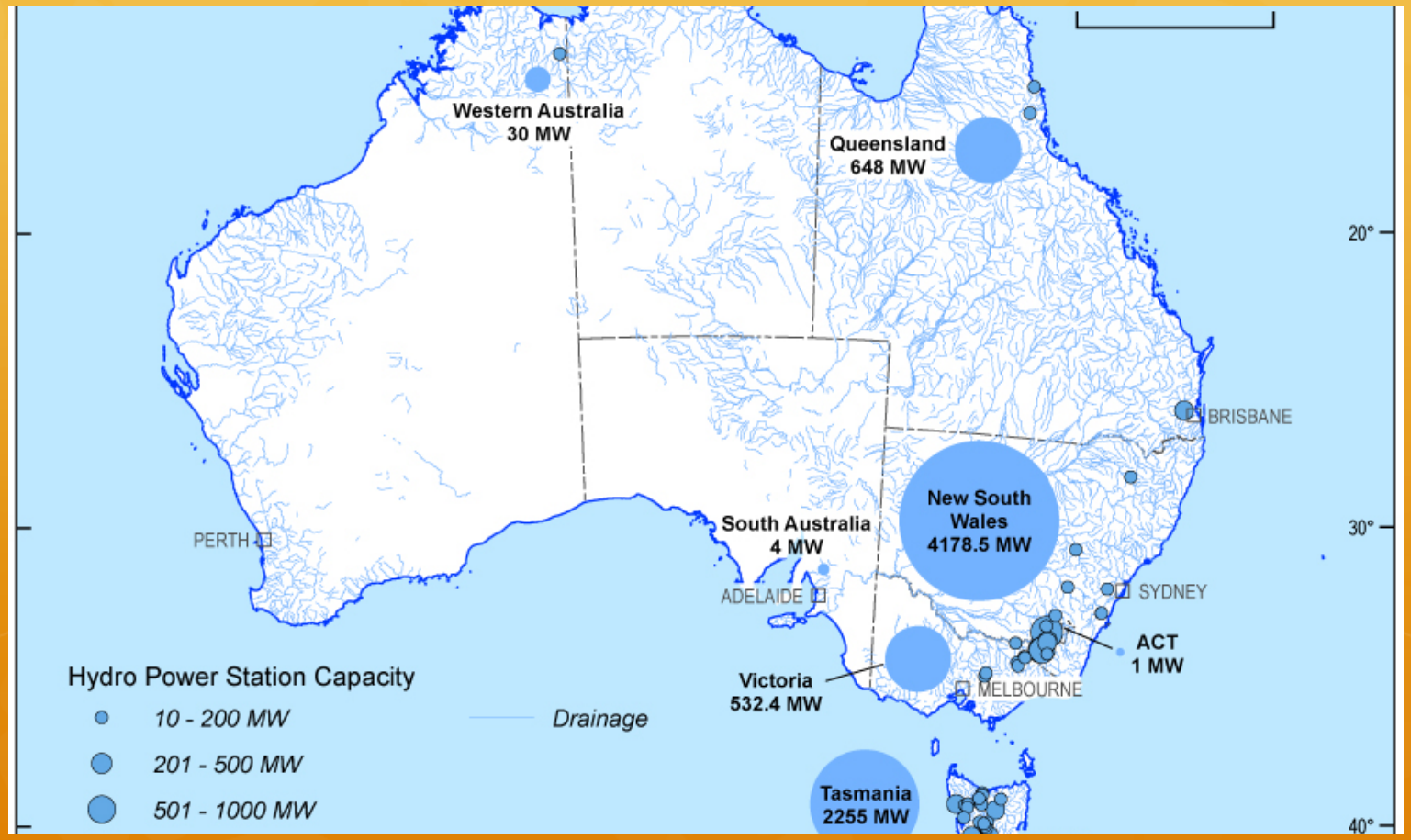
The provisions of the Consumer Guarantees Act 1993 will not apply to this data since it has been acquired for the purpose of a business.

Solar Power in Australia



Hydropower in Ausralia



Some Pros and Cons of Solar Power

- Pros:
- Clean and renewable
- Produce electricity in remote locations
- Long terms savings
- PV can be places on top of roofs: no space problems
- cons:
- initial cost
- Need of sunlight (no electricity at night)

Some Pros and Cons of Hydro

- Pros:
- Clean
- Consistent and reliable, independent of fossil fuels
- Generally speaking, doesn't require large investments.

- Cons:
- Use large reservoir (requires infrastructure and space)
- Upset the fish
- Concerns with earthquakes

Future Prospects…

The Road Not Taken

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim
Because it was grassy and wanted wear,
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I marked the first for another day!
Yet knowing how way leads on to way
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I,
I took the one less traveled by,
And that has made all the difference.

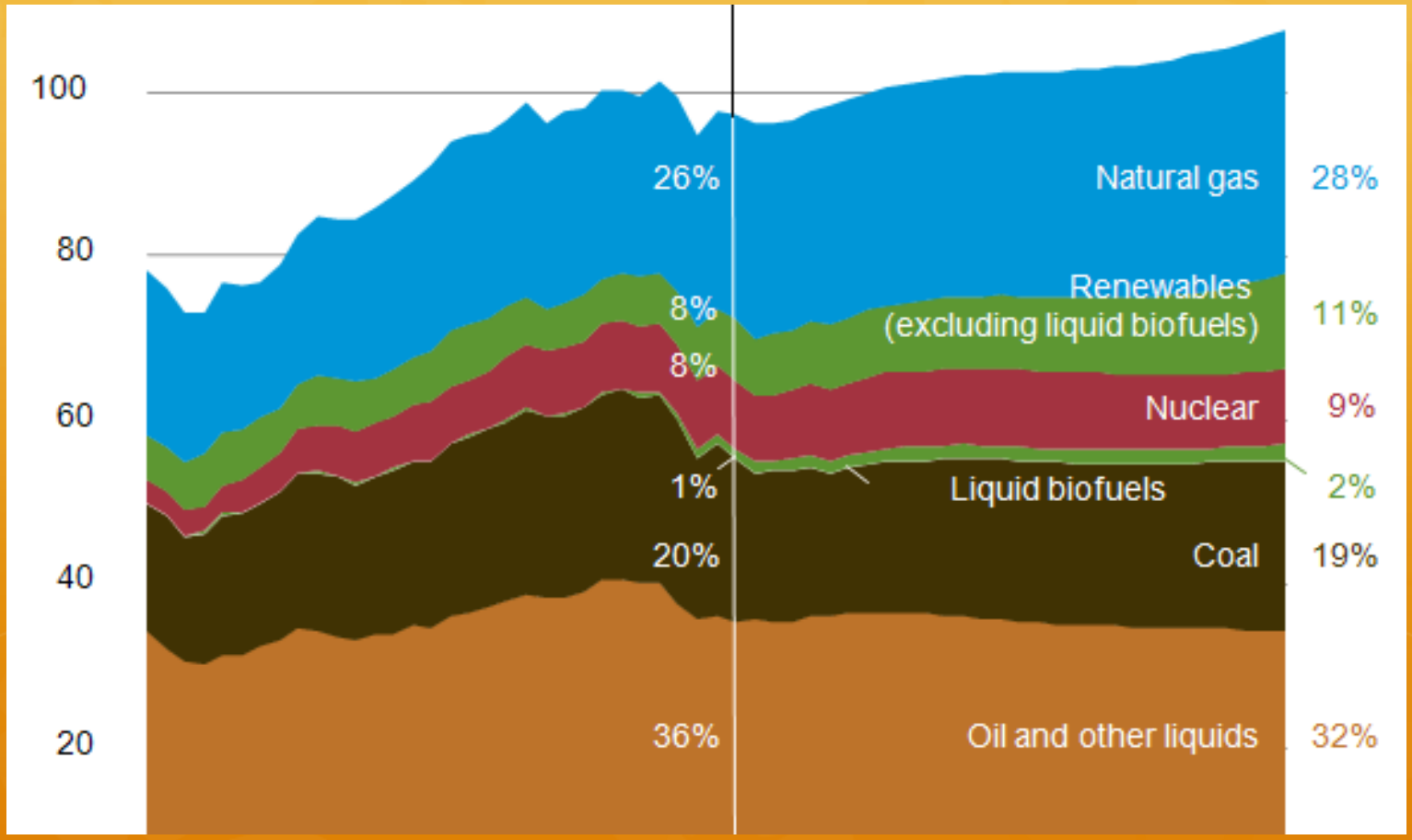
Robert Frost

“Soft Energies” will lead to…

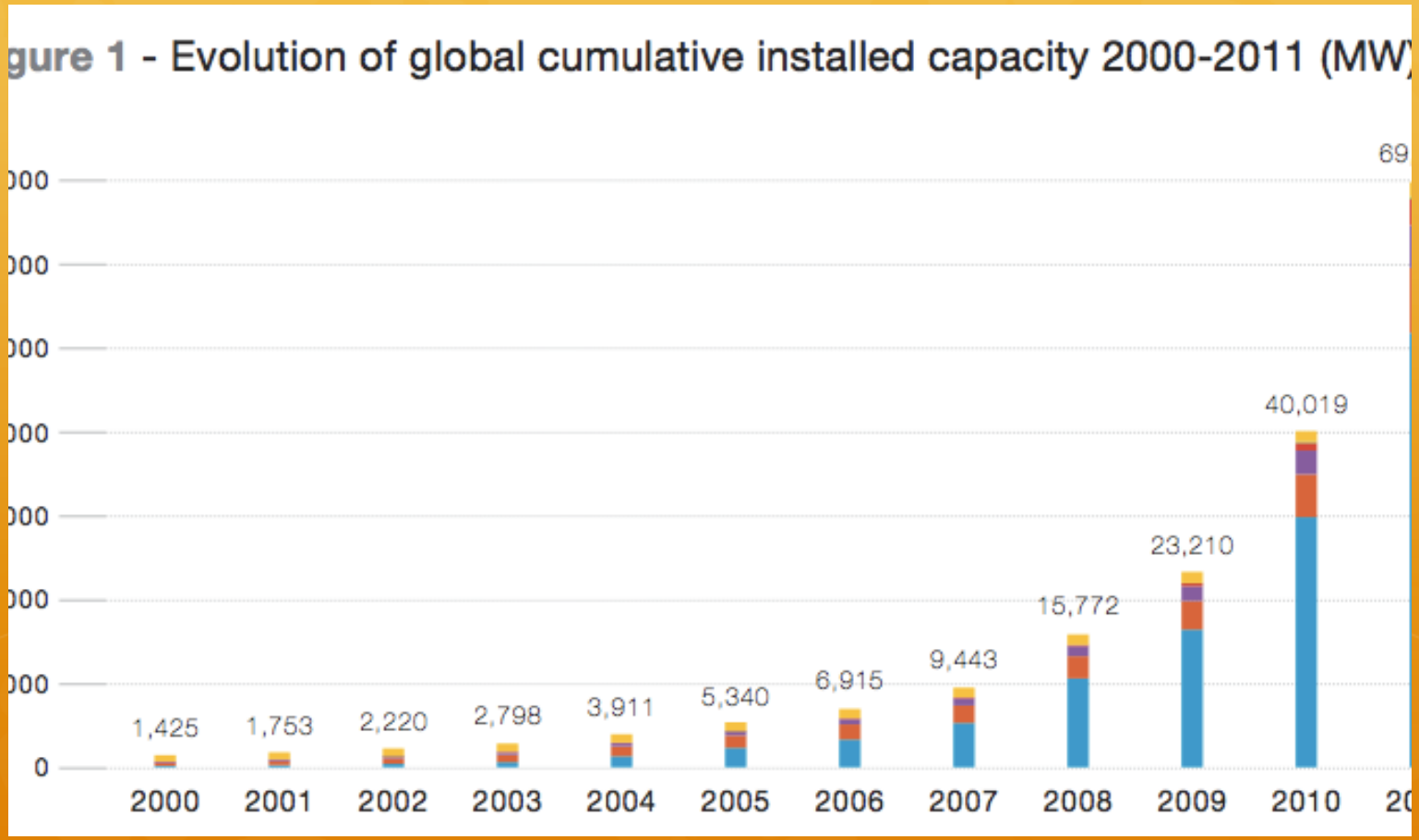
Lovins foresight:

- 29 % from Coal
- 33 % from oil and Gas
- 33% from Soft energy

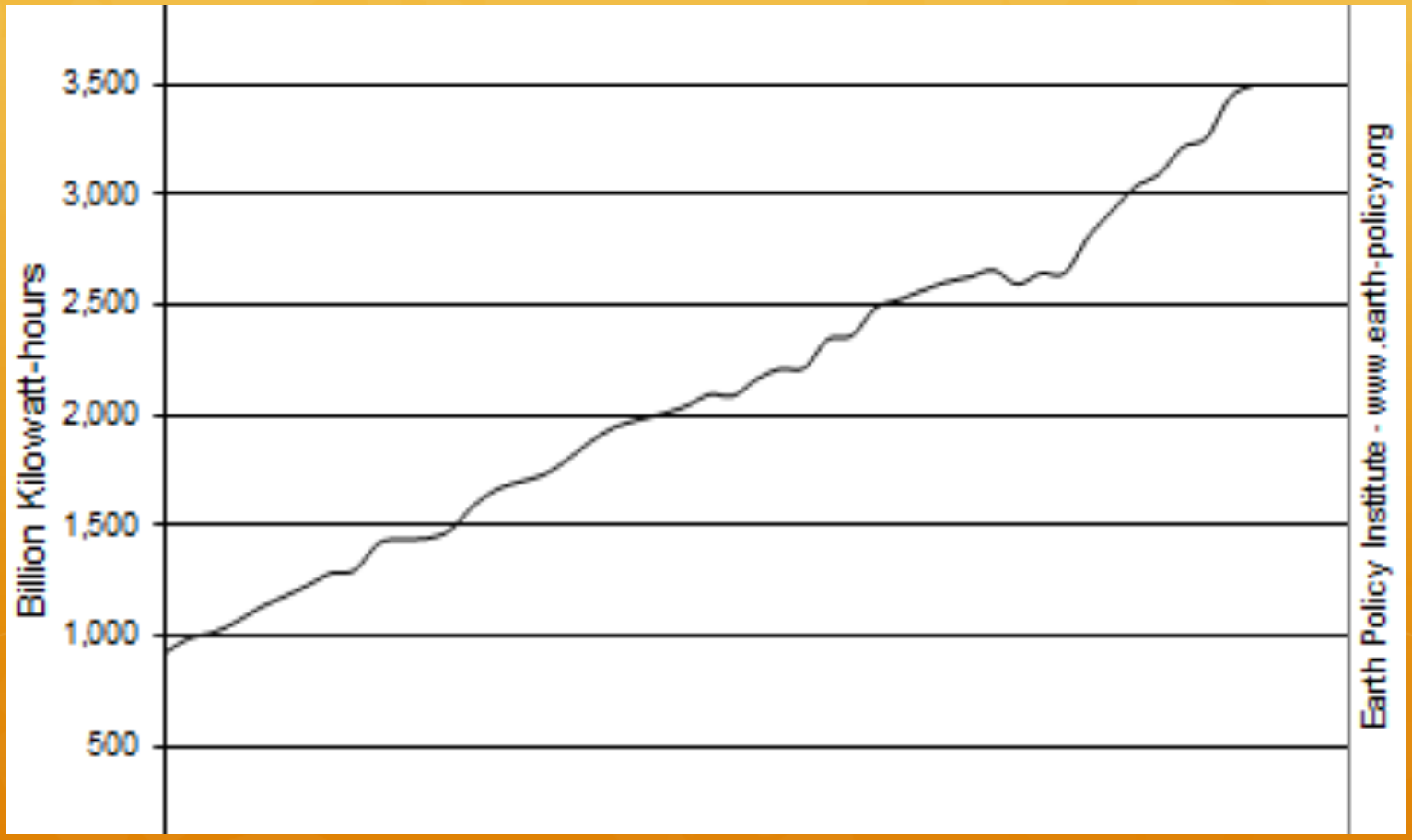
Future Prospects…



Solar is getting bigger and bigger!



A steady grow the for hydropower

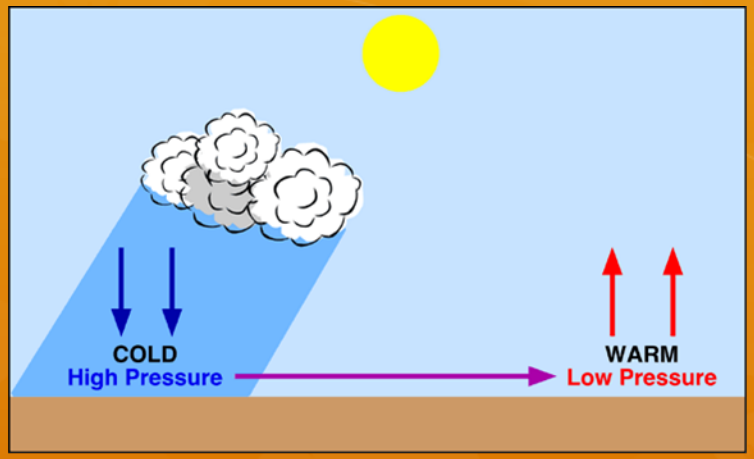


The Resource of Wind

- Brief review of history and use
- Design of a modern wind turbine
- Do the pros outweigh the cons?
- Wind power in U.S. and New Zealand

How wind is created

- When air moves from areas of high pressure to low pressure
- This is created by
  - The Earth's rotation
  - Irregularities on the Earth's surface
  - Solar Radiation



http://www.physicalgeography.net/fundamentals/7n.html

History of Use

- Primitive windmills have been around for over a thousands years
- Used in industry until the combustion of coal came about
- Charles Brush was the first to create wind generated electricity
- Palmer Putnam built the first turbine that was fed into a central electricity grid

Getting to Where We are Now

- Since Palmer Putnam: Turbine design has been slightly altered
  - Technology
  - Materials
  - Height
  - Size
  - Noise

http://www.guardian.co.uk/environment/gallery/2012/feb/28/world-of-wind-in-pictures#/?picture=385832839&index=6

Making of a Modern Wind Turbine

- Average windmill today is around 90 meters high
- The machine contains three blades, each up to 50 meters long
- Blades are uniquely designed so that there is a difference in air pressure caused when wind crosses over it, which in turn lifts the blade

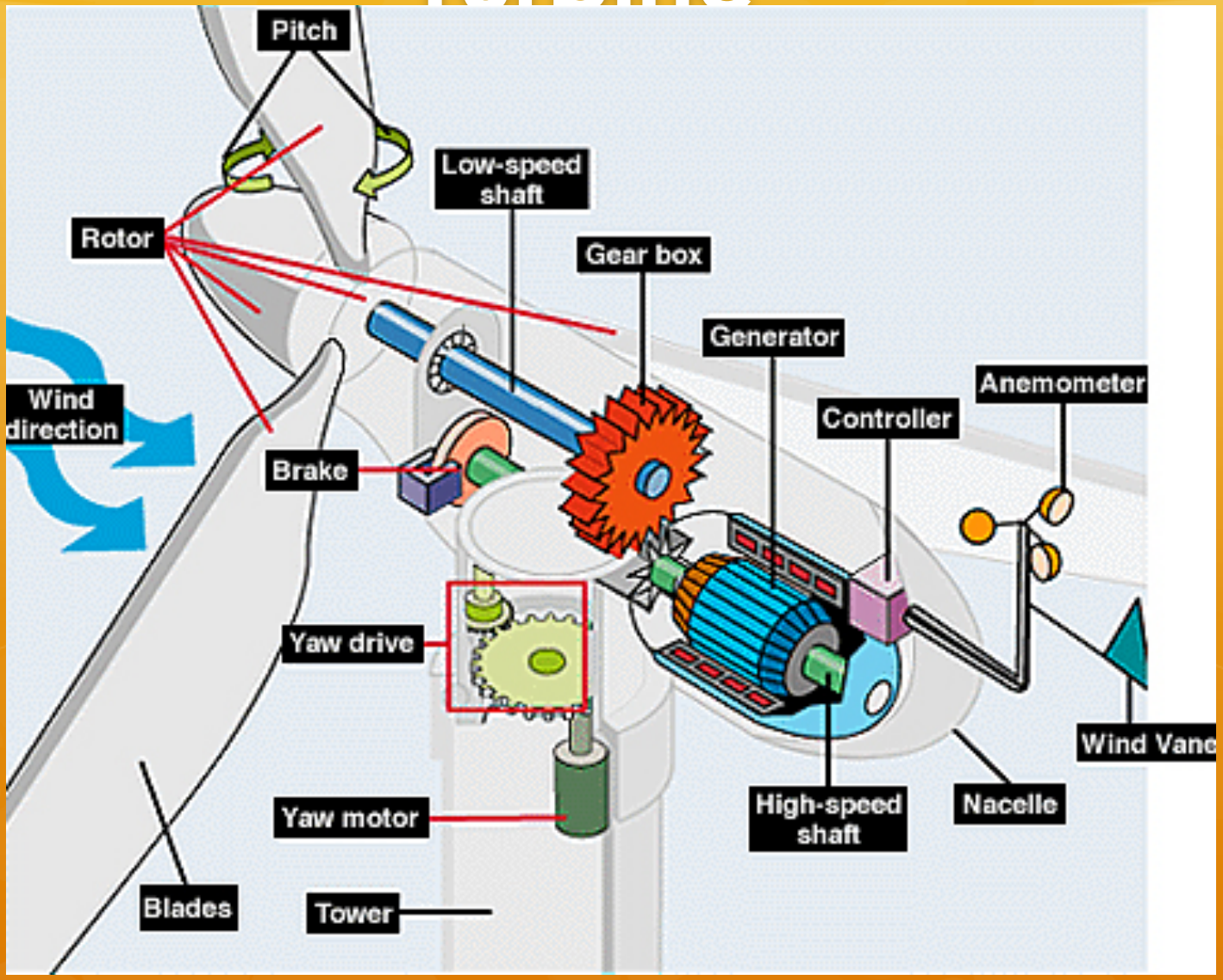
Making of a Modern Wind Turbine

- Blades are connected to a shaft that turns in the wind
- Wind is generally not strong enough to generate electricity with a regular generator alone
- Turbines contain a gearbox that spins to turn secondary gears to adequately twirl magnets in the generator
- These magnets excite a magnetic field in a conducting material, creating the electricity that is transported to the grid
- break that will shut down the turbine if the wind becomes too strong

Making of a Modern Wind Turbine

- Weather devices such as an anemometer measure wind speed and other meteorological conditions
- This information feeds into the turbine's computer
- The box that contains this computer is called a Nacelle
- Turbine then shifts in accordance to these readings
- Pitch and yaw are adjusted to best utilize the available wind power

Making of a Modern Wind Turbine



http://www.scientificamerican.com/slideshow.cfm?id=modern-wind-turbine-and-wind-farm

Making of a Modern Wind Turbine

- Materials
  - Blades are made of fiberglass or aluminum
  - Nacelle and blades weigh hundreds of metric tons
  - Supported by concrete foundation and steel tower of the turbine

Making of a Modern Wind Turbine

- Last step is to connect the turbine to a local grid

http://www.guardian.co.uk/environment/gallery/2012/feb/28/world-of-wind-in-pictures#/?picture=385832837&index=7

http://www.guardian.co.uk/environment/gallery/2012/feb/28/world-of-wind-in-pictures#/?picture=385833070&index=10

Pros

- Free renewable resource and tax free
  - "Wind is and infinitely renewable resource (Smil, 118)"
- No pollution, waste or CO_2 emissions
- Low maintenance
- Land on which the turbine resides can still be used
- Most cost-effective form of renewable energy

Disputable

- "There have been two big misunderstandings about wind electricity. One, that it can operate by itself, and two, that its cost is approaching the cost of conventional sources such as coal, natural gas or nuclear. Neither of those assumptions is correct. The first because, in the absence of energy storage or hydro generation, the only way wind can operate is as an appendage to coal or natural gas generation; and the second, because wind imposes costs on other parts of the system which no previous technology has imposed and requires more new transmission infrastructure than any previous technology has required (Taylor, 2012)."

Cons

- Expensive
- Intermittency and unreliability of wind
- Harmful to birds and bats
- Ruins aesthetic environment
- Noise Pollution
- Municipal zoning is often hard to overcome
- http://www.youtube.com/watch?v=UOY2GvViVRA

Disputable

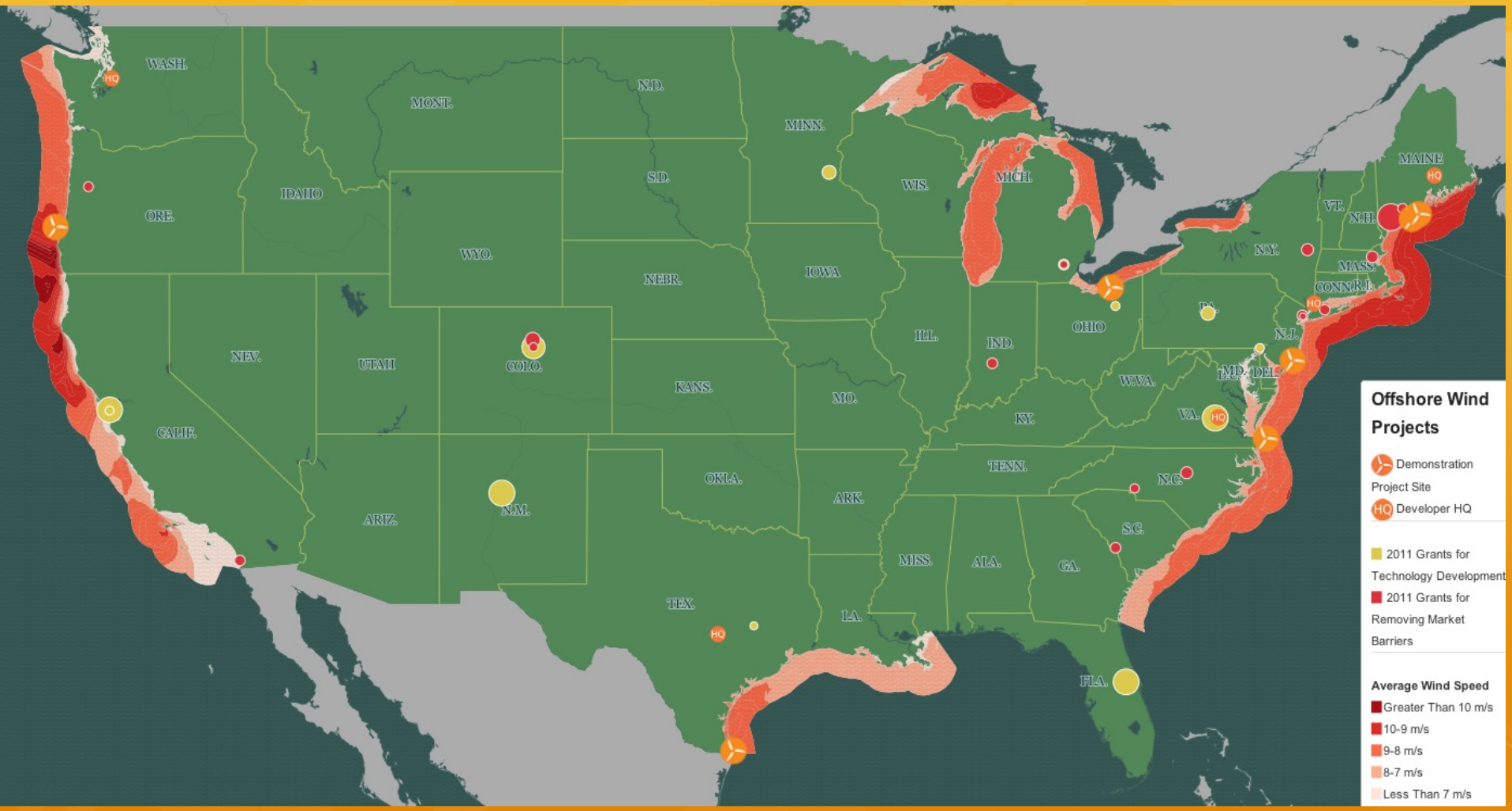
- Has been shown that tall buildings, windows, high voltage wires, and cats all cause more harm than wind turbines
- Noise pollution has been nearly eliminated through design (Smil, 121)
- http://www.telegraph.co.uk/earth/earthnews/8314206/For-and-against-wind-farms.html

Practicality of Wind

- Archer, Jacobson Study
- "Not everything that is technically feasible is economically acceptable (Smil, 123)."

Current U.S. Wind Power

- DOE-Wind Powering America-$200 million invested in offshore wind R&D
- Goal to produce 20% of electricity by 2030
- Running an offshore wind program
  - 7 projects in the planning phase
  - Each receive $4 million to complete planning, engineering and site evaluation
  - Three are then chosen to receive more funding
- Tax credit that offset 30% of cost to build a turbine ended in 2013
- New tax incentive for 2.2 cents per kWh for wind generated electricity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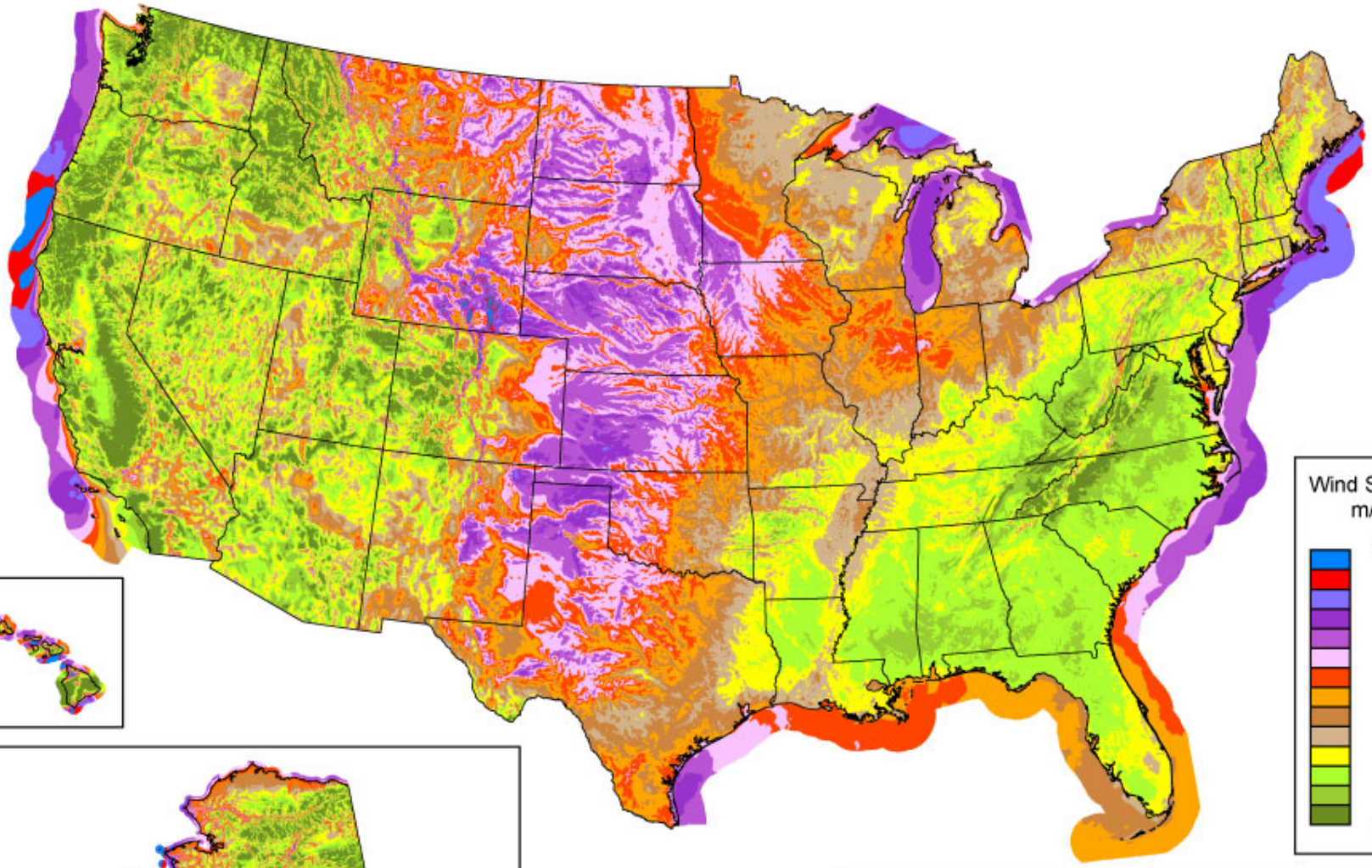
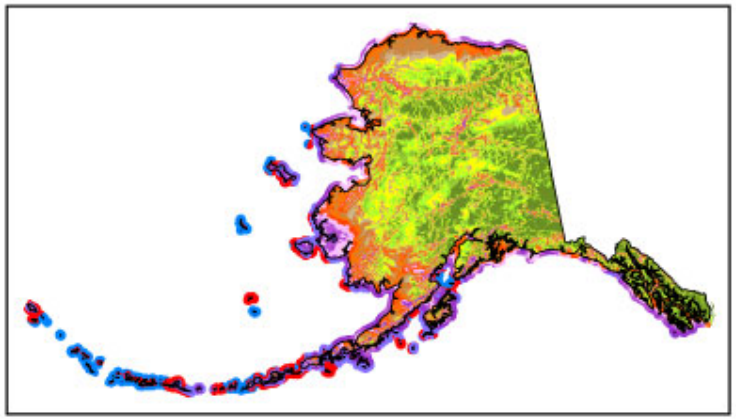
TEX.
LA.
FLA.
HQ
Offshore Wind Projects
Demonstration Project Site
Developer HQ
2011 Grants for Technology Development
2011 Grants for Removing Market Barriers
Average Wind Speed
Greater Than 10 m/s
10-9 m/s
9-8 m/s
8-7 m/s
Less Than 7 m/s

United States - Land-Based and Offshore Annual Average Wind Speed at 80 m





Source: Wind resource estimates developed by AWS Truepower, LLC. Web: http://www.awstruepower.com. Map developed by NREL. Spatial resolution of wind resource data: 2.0 km. Projection: Albers Equal Area WGS84.

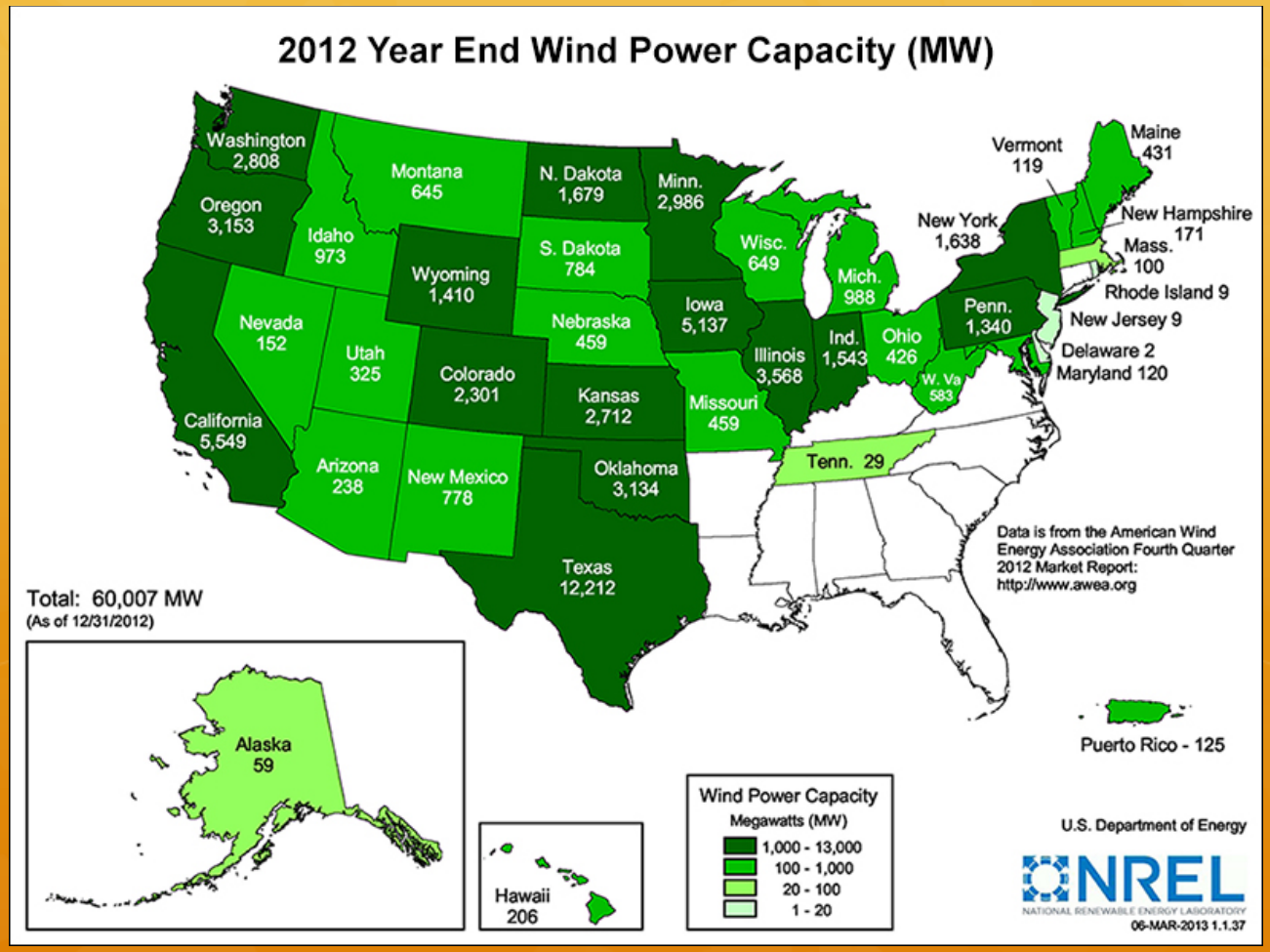
AWS Truepower™
Where science delivers performance.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

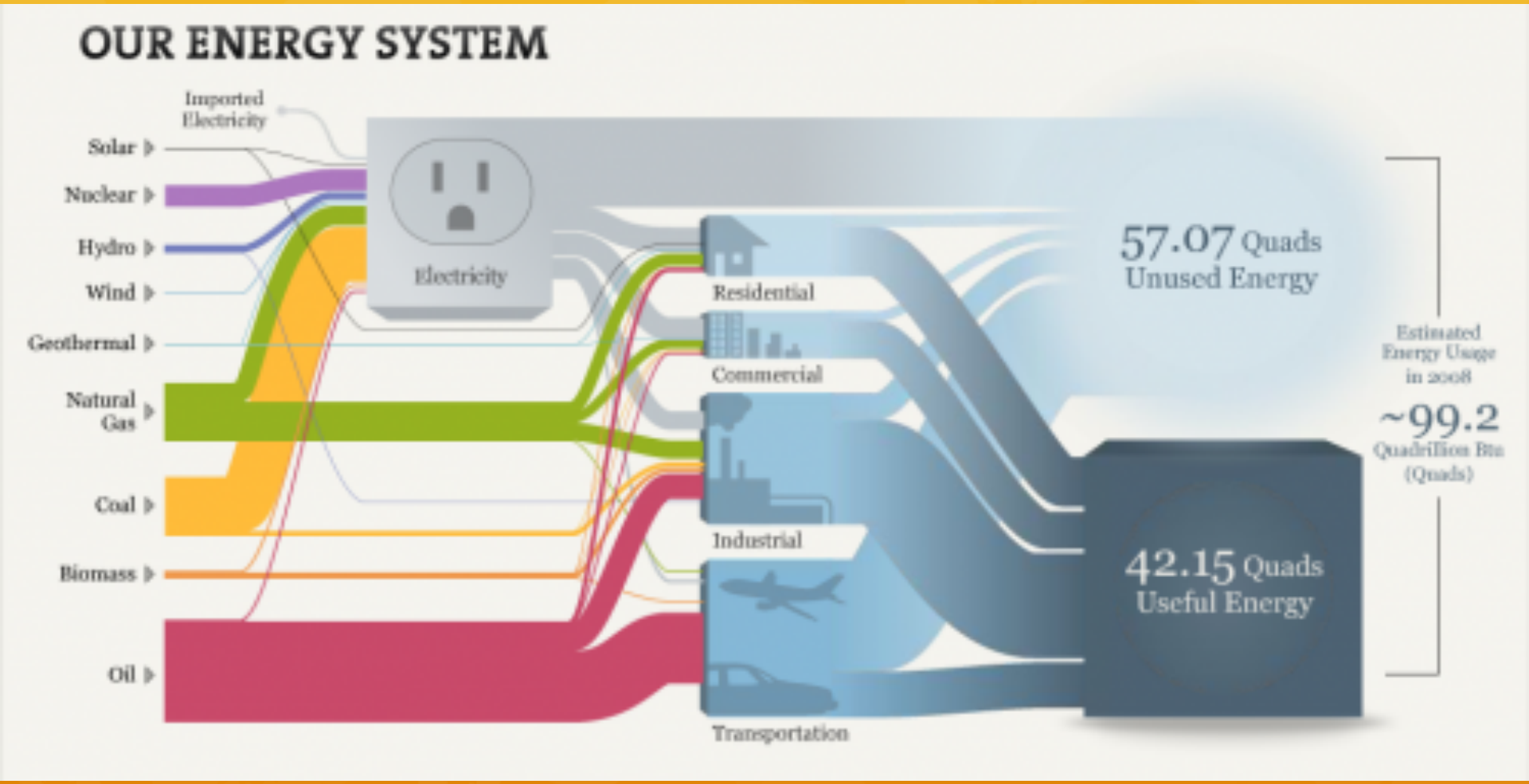
09-JAN-2012 3.1.1

http://www1.eere.energy.gov/wind/resource_assessment_characterization.html

Current U.S. Wind Power



http://www.windpoweringamerica.gov/wind_installed_capacity.asp



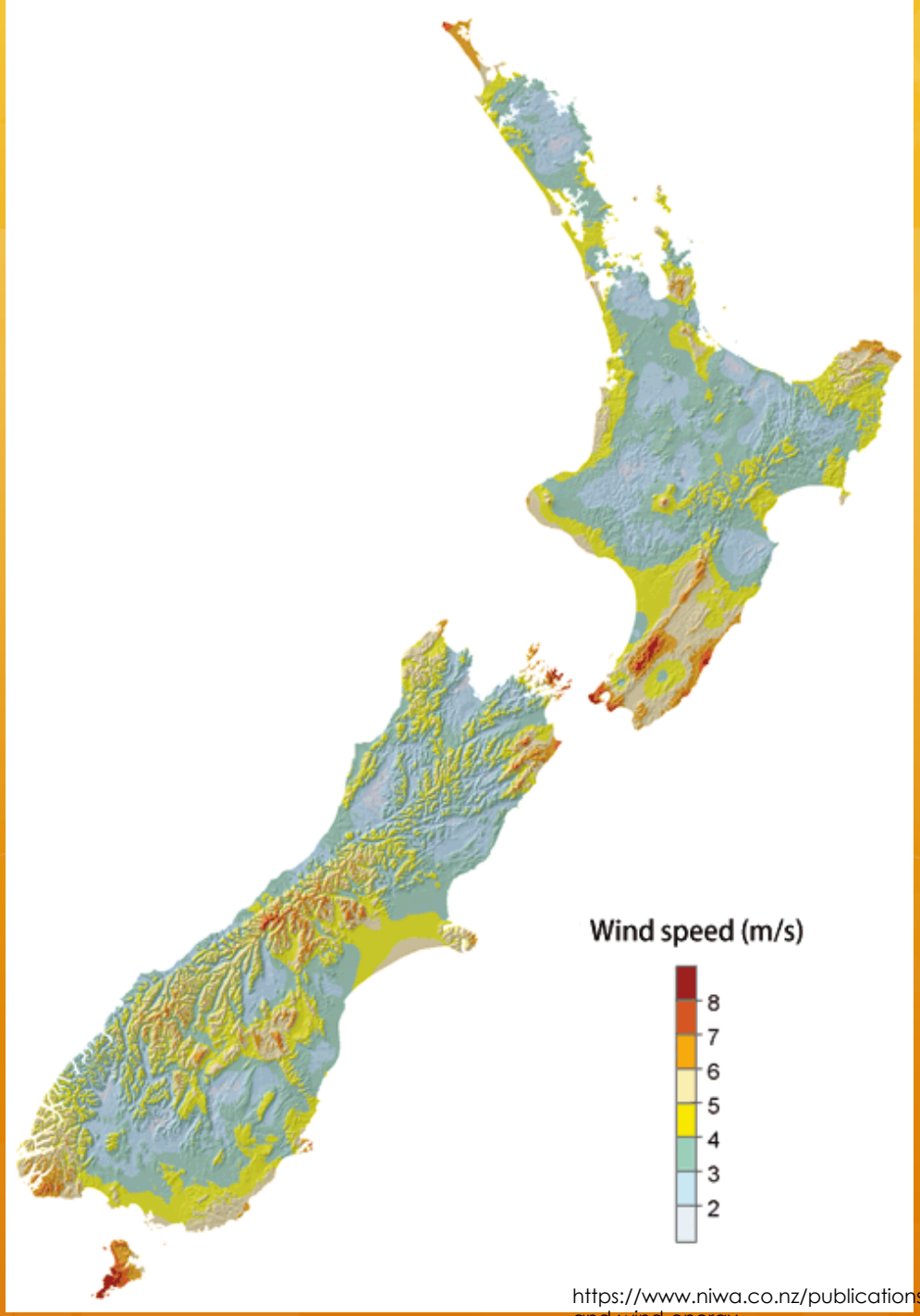
http://needtoknow.nas.edu/energy/interactive/our-energy-system/

Future of U.S. Wind Power

- Low-wind and offshore technologies are taking off
- Looking to utilize a lot more of the central area of the country
- Price of wind energy will remain more than competing sources
- DOE aims to reduce the cost of onshore wind by 18% and offshore by 63% by 2020
- Goal is to have 20% of demand covered by wind power by 2030
- Bird and bat issue is being addressed

Current New Zealand Wind Industry

- Installed capacity of 622 megawatts powering 4.9% of total electricity
- 17 wind farms working or under construction
- New Zealand's Energy Efficiency and Conservation Authority "works to remove barriers to, and encourage the uptake of, all renewable energy technologies (eece.govt.nz)."
- Largely industry run sector
- New Zealand Wind Energy Association is a membership based industry group



https://www.niwa.co.nz/publications/wa/vol13-no4-december-2005/wind-and-wind-energy

http://www.freitasm.com/1053

Future of New Zealand Wind Power

- "Wind blows strongly enough for wind-power companies to survive without the government subsidies available in other countries (Wind energy in New Zealand, pg. 2, http://www.teara.govt.nz)."
- Carbon tax incentives are expected to cause power companies to benefit from building wind turbines

Biofuels

History

- Henry Ford
- Model T could run on gasoline, ethanol, or both
- US production was up and down throughout history

Expectations

- Senate Bill passed in 2007 – mandates production will be no less than 36 billion gallons of ethanol for 2022
- Energy content = 65% of gasoline , ethanol would only reach 13% of the estimated 2022 gasoline demand

Year	Production	Stock Change	Consumption
1990	0.75	Not available	Not available
2000	1.62	-0.03	1.65
2007	6.52	0.44	0.07
2008	9.31	0.53	0.16
2009	10.94	0.20	0.10
2010	13.30	-0.38	0.06
2011	13.93	-1.02	0.01
2012[2]	11.15	-0.29	0.02

Perfect Green Energy Solution or Not

- Is it best choice to cut dependency on oil and lower carbon?

- http://www.youtube.com/watch?v=59R-NqykoXs

Corn based ethanol

- Entire Corn Harvest (2005) 280 million tons
- Convert entire harvest to ethanol and it would only meet 13% of the total gasoline consumption

- In order for ethanol to take over gasoline, we would need 220 million hectares of arable land
- 20% larger than the country's total arable land

Producers

- Archer Daniels Midland
- VeraSun
- Cargill
- 30% of US ethanol

- Federal subsidies – $5.5 – $7.3 billion in 2006 for US
- & $5billion for EU

Other Problems

- Net energy return for corn-based ethanol isnt so good (. 77-1.06)

- Environmental Degradation
  - 1. Largest source of agricultural soil loss
  - 2. High uses of nitrogen fertilizers (reaches to the Mississippi and Gulf of Mexico)
  - 3. Underground water would be essential causing more mining of the Ogallala aquifer
  - 4. Feed for livestock (mixed with soybeans)

Net energy return and the effect on the nitrogen cycle (would increase nitrous oxide)

Sugar Cane

- Does not require any nitrogen fertilizers
- Energy return much higher 8.3-10
- Only Brazil has the right conditions for a large profitable biofuel industry

Biodiesel

- Accounts for 15% of the global biofuels
- Extracted from oil-bearing crops
- Tropics from oil-palm and jatropha
- Europe has diesel engines for almost half of all passenger cars
- Idea is to make it from spent coffee grounds

Cellulosic Ethanol

- "alcohol fermented form sugars obtained by breaking down cellulose."
- All from Waste (agricultural, corn stover, wood, food)
- US Dept of Energy invested in 6 plants by 2011

Corn stover

- 200 million tons annually
- 5% is used for cattle feed
- Rest is used to replenish the soil and to prevent soil erosion
- Calculations to keep soil rich and prevent erosion only 35% can be removed from fields
- Estimated 80 million tons which would equal no more than 3% of Gasoline market
- Operation plants and the process is very expensive

New Zealand

- Requires some mixture of biofuel with gasoline
- EarthRace project (Peter Bethune) – round-the-world powerboat speed record, powered by biodiesel from human fat. (liposuction)
- "In Auckland we produce about 330 pounds of fat per week from liposuction, which could make about 40 gallons of fuel."
- Air New Zealand
- http://www.youtube.com/watch?v=MtmcdDI_oOc

Not the Solution

- Unrealistic
- "gold rush for algae"
- "Liposuction"

- "More important than the fact that liquid biofuels cannot displace refined oil products in transportation is that they should not."

Energy Economics/Plans In the USA…

- USA ranked third overall in terms of total investments with just over USD25 billion
- The US government support for renewable energy includes feed-in tariffs for production and investments.
- Renewable Portfolio Standard (29 states have one)

In New Zealand…

- Generation which results in greenhouse gas emissions will be charged a carbon cost (this includes geothermal generation).
- Wind generation is automatically dispatched; it does not need to be bid into the market.
- Generation from all other renewable sources is treated the same as generation from carbon sources (lowest bid price is dispatched first).
- Remuneration is available for electricity produced (feed is tariffs).

In Australia:

- The Australian Renewable Energy Agency (ARENA)
- The Plan : Securing a Clean Energy Future

- The R&D tax incentive

- Feed-in tariffs:

  No national based feed-in tariffs yet

- **Target**: 20 percent by 2020 (similar to the US)

Renewables in New Zealand

- Renewables supply New Zealand with 75% of its electricity
- Most utilized include hydro and geothermal.
- Wind utilization is still scant, but constantly growing
- Almost all transport in New Zealand relies on fossil fuels
- Solar energy is being used to heat water for homes and to generate electricity
- Marine energy is being researched and developed in New Zealand

Renewables In the U.S.

- 9% of total U.S. energy come from renewables
- 13% of electricity consumption
- Two most utilized are hydro and wind
- Approximately two-thirds of renewable energy comes from hydroelectric sources
- About a fifth comes from wind.
- Wind power is mostly used in the home sector

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