

Alternate Energy Economy



A SPECIAL ANALYSIS FOR
DURABLE GOODS REPORT
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The Misdirected Energy Debate

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- Should “emerging energy” start ups be subsidized?
 - Wrong question. How about this:
- Is the proposed technology a net producer of energy over its useful life?
- There is no public interest in any technology that is not a “Net Producer” of energy.

- No amount of money or political will can reverse the laws of physics.
- No public policy debate is warranted for any technology that is not a “Net Producer” of energy.

Rules for Useful Net Producers of Energy

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- **Net Producer**: lifetime Energy Return on Energy Invested (EROEI) must be greater than 100% (break even)
 - If it doesn't pass this test, nothing else matters
- **Useful Net Producers must also be:**
 - **Abundant** and easily accessible
 - **Concentrated** for efficient collection, distribution
 - **Transportable** to deliver to point of use or conversion
 - **Storable** in concentrated form until needed
 - **Convertible** on demand into final form (heat, light, or motion)
 - **Economical** competitive price

Sources of Energy

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HYDROCARBON, NUCLEAR, HYDROELECTRIC

ALTERNATE, “RENEWABLE”

Sources of Electrical Energy

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	EROEI	Medium	Capacity Factor	
Solar Electric	30%	Electricity	30%	Max available surface energy: ~300 watts per sq meter. 100 w/m net
Solar Concentrator	40%	Steam/Electricity	30%	
Windmill	20%	Electricity	15%	All EU installations below 10%
Hydro-electric	500%	Electricity	100%	
Thorium fission	400%	Steam/Electricity	98% (est)	
Uranium fission	200%	Steam/Electricity	92%	
Hydrogen fusion	0	Steam/Electricity	na	
Coal	700%	Steam/Electricity	75%	
Oil	600%	Steam/Electricity	80%	
Natural Gas	600%	Steam/Electricity	85%	

- EROEI = Lifetime Energy Return on Energy Invested .
- Capacity Factor: What portion of theoretical capacity can be used in practice

Sources of Liquid/Gas Transport Fuel

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	EROEI	Medium	Capacity Factor	
Algae oil	60%	Liquid	100%	
Ethanol	60-80%	Liquid	100%	corn/cane fermentation
Ethanol	30-50%	Liquid	100%	Cellulose fermentation - switchgrass
CNG/LNG	300-500%	Gas/Liquid	100%	
Biodiesel	80%	Liquid	100%	
Drilled oil	500%	Liquid	100%	Diesel or gasoline
Drilled natural gas	600%	Gas/Liquid	100%	

- EROEI = Lifetime Energy Return on Energy Invested .
- Capacity Factor: What portion of theoretical capacity can be used in practice

There are Only Three “Net Producers”

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- Hydrocarbon combustion
- Nuclear fission (not fusion)
- Hydro-Electric

- Everything else is either:
 - R&D (if you can prove on paper that it might work)
 - A hobby (if it's really cool but it can't break even)

Magical Energy Sources: Gas from Air

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- UK research group makes gasoline from air! Needs funding to scale to commercial quantities.
 - Uses CO₂ from the air plus steam and electricity
 - Methods are well known. Require massive energy inputs. Using a lot of energy to make a little energy is a quaint business model.
 - The electricity input to this process is mostly derived from hydrocarbon combustion.
 - Any process that uses hydrocarbon energy input to produce hydrocarbon energy with a net positive output, violates the laws of thermodynamics.
 - Any system that delivered a net increase in energy would cause the universe would explode.
 - Using wind energy is the usual counter argument. But a windmill takes more energy to build than it will ever produce. Same result.
 - <http://www.independent.co.uk/news/uk/home-news/exclusive-pioneering-scientists-turn-fresh-air-into-petrol-in-massive-boost-in-fight-against-energy-crisis-8217382.html>

Uses of Energy

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FIXED AND MOBILE ENERGY USE

Basic Uses of Energy

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- **What we use it for**
 - Heat
 - Light
 - Rotary or linear motion
- **Where we use it**
 - Fixed location (homes, offices, factories)
 - Mobile (auto, truck, rail, aircraft, ships, laptops, cellphones)

Confusion over Sources and Uses

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- Windmill used for stock watering requires large amounts of energy to make the steel. Far more than the lifetime energy output. It's still useful when other sources are unavailable. But it's a user, not a source.
- Ethanol looks like a net producer only when analyzed as a by product of some other process. As a stand alone enterprise it's a user.
- Electricity is not a source of energy. It's an intermediate form used for transport to point-of-use.
- A battery is not a source of energy, it's a fuel tank.

Energy Concentration: The Practicality Test

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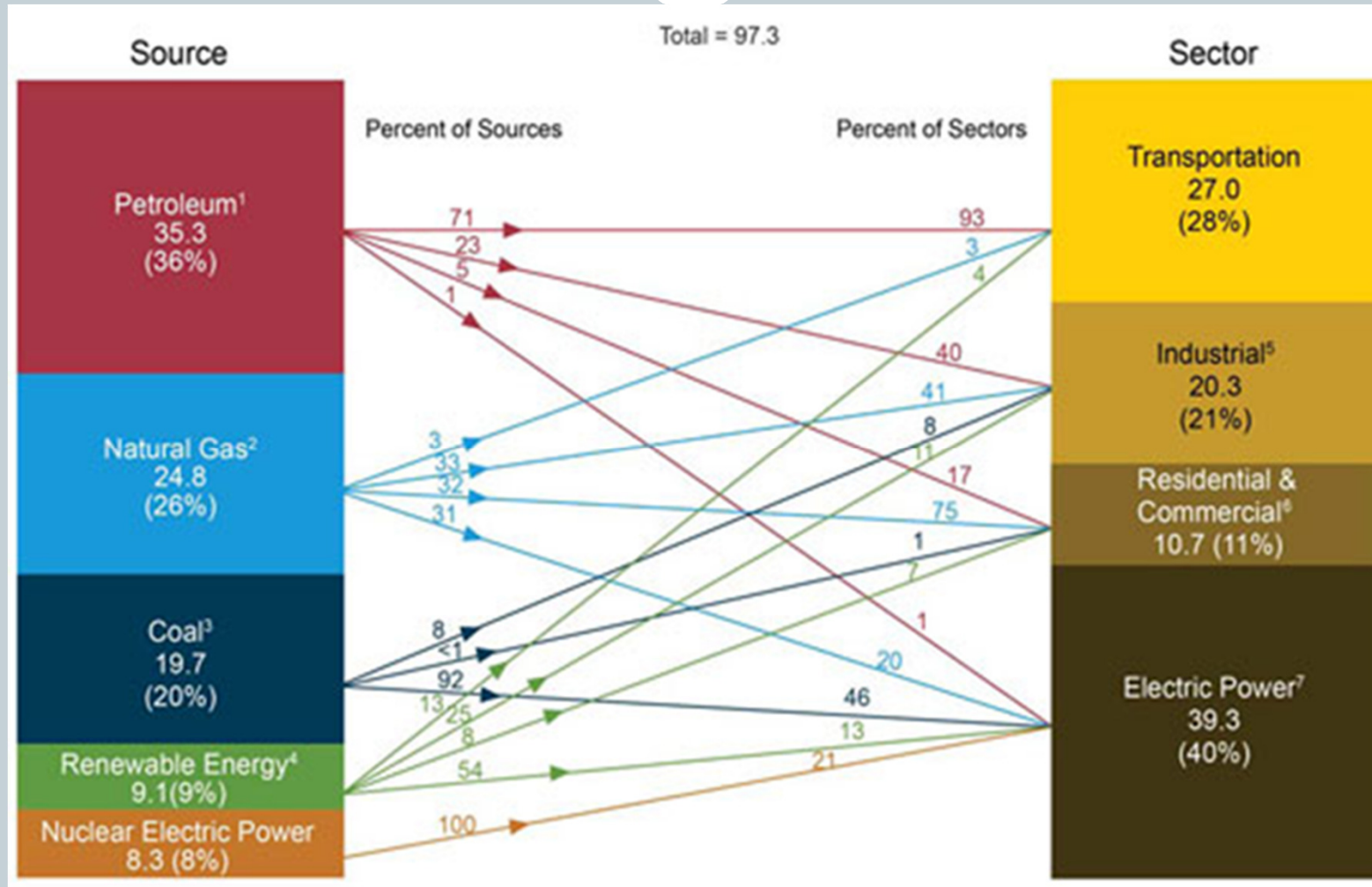
	M-J/Kg	M-J/L
Coal, anthracite	32	72
Diesel	46	37
Body fat metabolism	38	35
Gasoline	46	34
100LL Avgas	44	32
Gasahol e85	33	26
Carb Metabolism	17	26
Ethanol	30	24
Battery, Lithium-ion	0.72	2.20
Battery, NiCd	0.14	1.08
Battery, NiMH (auto)	0.25	0.50
Battery, Lead Acid	0.14	0.36
Methane	56	0.04
Hydrogen	143	0.01
M-J/Kg = mega-Joule per kilogram		
M-J/L = mega-Joule per liter		

Energy Concentration: Transportation Energy

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- Portable energy source requires
 - High energy concentration
 - Ease of handling.
- If you were trying to invent a perfect portable energy source for transportation, it would look like liquid petroleum.
- Hydrogen is a great fuel for rockets because weight is the overriding consideration. Big headache for vehicles.
- Coal is a great fuel for fixed power plants because volume is the overriding consideration. Big headache for mid-air refueling of fighter jets.

Source and Use in the US



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