Economic Issues in Generation

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Discussion Overview

I. Regulatory Context
II. Defining long-run marginal cost
III. Identifying components of long-run marginal cost of coal-fired power

I. Regulatory Context:

In what kind of regulatory processes, public/private collaborative efforts does the MPSC consider long-run cost of electricity?

- The most recent resource planning process the MPSC has been engaged in began in 2004 with Commission Order U-14321 which created the **Capacity Need Forum (CNF)**

- While the CNF report was completed in January 2006, Governor Granholm issued Executive Directive 2006-2 calling for development of an updated plan for meeting the state's future electricity needs.

- The **21st Century Energy Plan (CEP)** was complete by January, 2007.

- In both the CNF and the 21st CEP processes, the MPSC served as a central point of stakeholder coordination and modeling efforts.

- Neither process represented a contested administrative hearing culminating in a binding "final order" by the Commissioners.

2008 Public Acts 295 & 286 and the Certificate of Need Process

- The ~ 3 yr resource planning effort led by the MPSC culminated in November 2008 passage of Public Acts 295 & 286 which modified current law to propagate the policies and generation expansion plans identified in the CNF & 21st CEP.

- P.A. 286 identified and described a new regulatory process, *Certificate of Need*, by which the MPSC would review, analyze and recommend a regulated utility's generation expansion plan → the MPSC now considers the long-run cost of electricity within a legally-binding framework.

2009 E.D – Electric Generation Alternatives Analysis

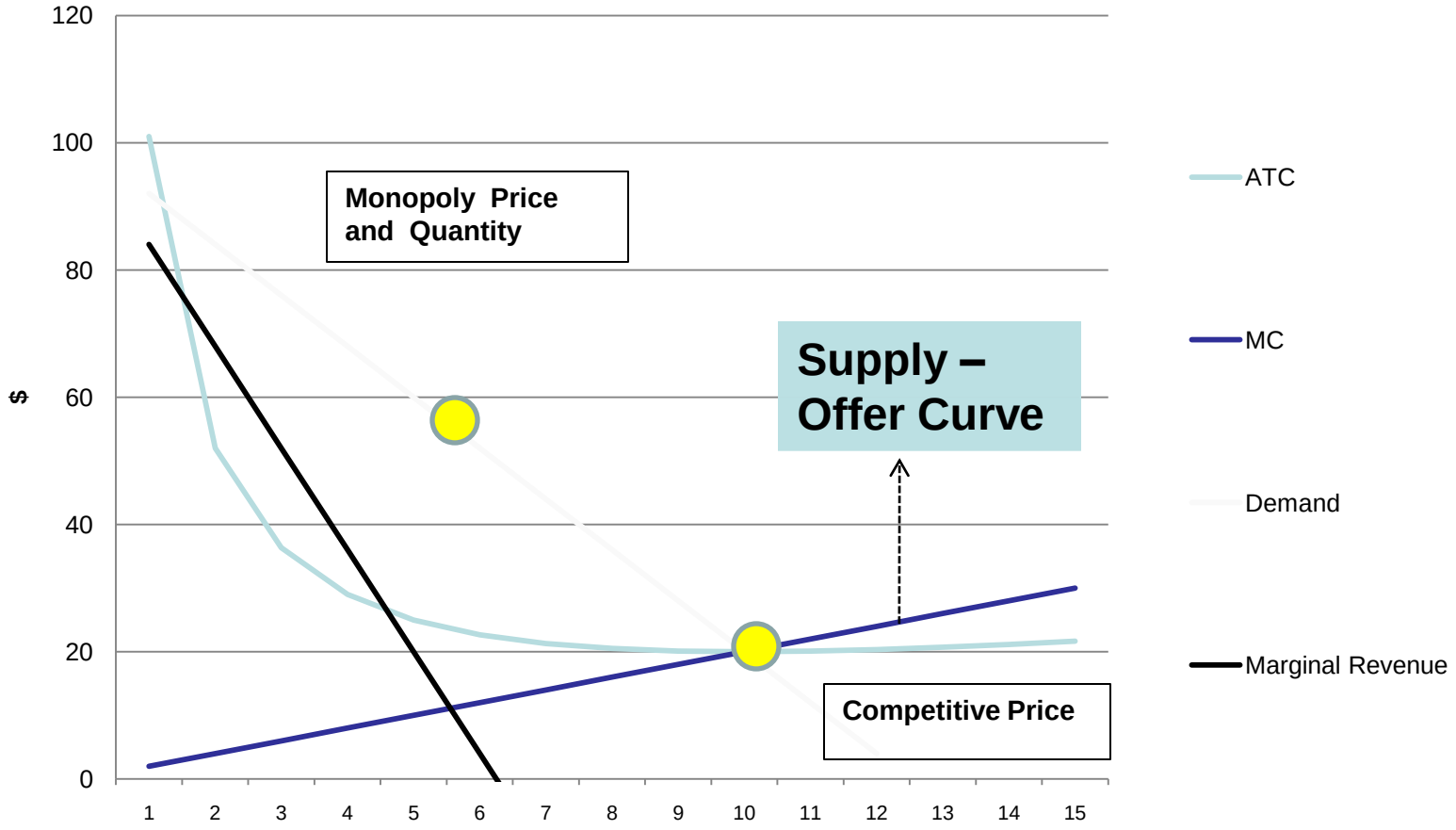
- On February 3, 2009, Governor Jennifer M. Granholm issued Executive Directive (E.D.) 2009-02 directing the Michigan Department of Environmental Quality (DEQ) to "determine whether there are feasible and prudent alternatives consistent with the reasonable requirements of the public health, safety, and welfare that would better protect the air, water, and other natural resources of this state from pollution than the proposed coal-fired electricity generating plant before issuing a permit to install for the construction of the proposed facility."

- E.D. 2009-02 requires the Michigan Public Service Commission (MPSC) to provide technical assistance to the DEQ in making determinations required under the Directive.

II. Defining Long-Run Marginal Costs

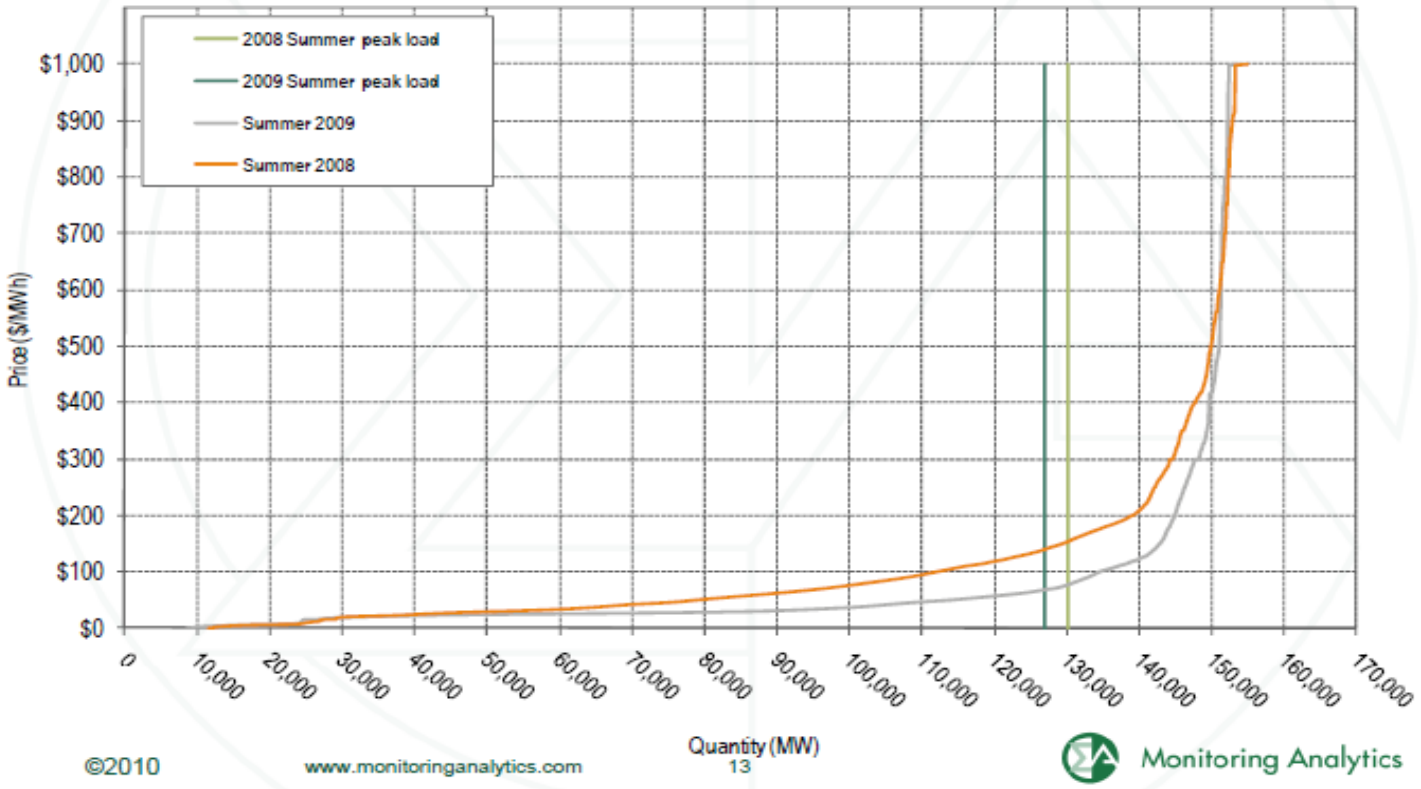
Is there really a difference between long run marginal costs and long average total costs?

Production Cost Curves and Equilibrium Market Prices in Theoretical Competitive and Monopolistic Markets



Real World Electricity Market Supply – Offer Curves

Figure 2-1 Average PJM aggregate supply curves: Summers 2008 and 2009



- In the ***short run***, power suppliers' market offers do not necessarily reflect the price needed to recover total volumetric costs.

- Offers can just reflect fuel and variable O&M

- Offers can be even be negative which reflect the opportunity cost of foregone sales between the shut-down and start-up times

- In the ***long run***, average total cost of generation will be the minimum offer

Coal Plant Market Revenues and Profitability

- Most traditional baseload generation generally offers power into market at pure marginal cost of operation.

- The difference between the price the generator receives and the marginal cost offer must be sufficient to, on average, cover all fixed costs.

- Critical drivers of market price include:
  - available “local” capacity + imported capacity via transmission relative to demand
  - natural gas prices

Estimated Costs and Market Revenues of Coal Plant New Entrants – 2009 PJM SOM

Figure 2-14 PJM real-time, monthly, load-weighted, average LMP: Calendar years 2005 to 2009

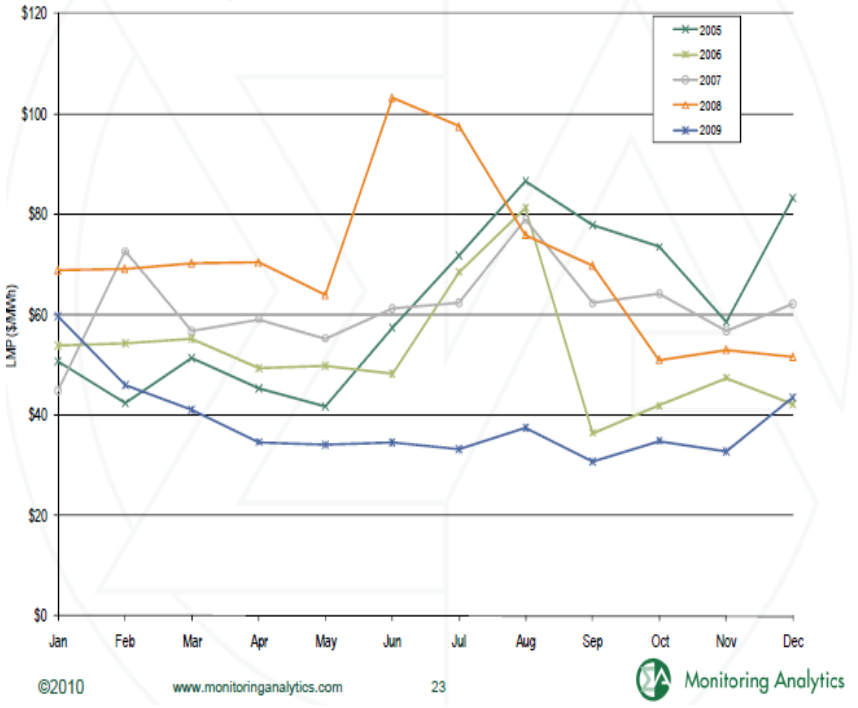


Figure 3-8 New entrant CP real-time net revenue and 20-year levelized fixed cost as of 2009 by LDA (Dollars per installed MW-year): Calendar years 1999 to 2009

- CP design :

  - western Virginia sub-critical steam
  - selective catalytic reduction system (SCR) for NO_x control
  - flue gas desulphurization (FGD) system with chemical injection for SO_x
  - mercury control
  - baghouse for particulate control

Economic Dispatch Assumptions:

-Accounts for effects of hourly local air ambient temperatures on plant heat rates

- Unit is dispatched when market price > variable operating costs

-Unit availability adjusted for forced outage rates

- Real-time, Day-Ahead, Capacity & Ancillary Services Market Revenues

	Natural Gas	Low Sulfur Coal
1999	$2.62	$1.62
2000	$5.18	$1.39
2001	$4.52	$2.14
2002	$3.81	$1.54
2003	$6.45	$1.76
2004	$6.65	$2.74
2005	$9.73	$2.88
2006	$7.40	$2.58
2007	$7.87	$2.53
2008	$9.95	$4.60
2009	$4.73	$3.16

In the long run, marginal costs of coal-fired power generation will equal or exceed those of its average total cost……

The question becomes, “What will the long-run ***average total cost*** of coal-fired power generation be?”

III. Identifying Long-Run Components of Coal-Fired Power Average Total Cost

CMS: ASPSC Cost Estimates

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
NOx	$/Ton	2,626.56	2,584.54	2,428.39	2,489.10	2,551.33	2,720.71	2,896.97	2,894.62	2,908.68	2,629.95	2,378.70	2,152.23	1,948.12	1,764.19	1,598.45	1,449.14	1,314.64
SO2	$/Ton	174.25	458.61	742.96	1,027.32	1,311.67	1,277.24	1,440.09	1,697.50	1,913.94	1,961.78	2,010.83	1,648.88	1,352.08	1,108.71	909.14	745.49	611.31
CO2	$/Ton	0.00	0.00	0.00	22.30	23.72	25.46	27.29	29.05	30.75	32.53	34.46	36.71	39.53	42.54	45.75	49.19	52.86
Fuel	$/MMBtu	1.98	2.51	2.59	2.66	2.73	2.82	2.99	3.10	3.19	3.28	3.38	3.47	3.57	3.67	3.77	3.87	3.97
Heat Rate	Btu/kWh	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134	9,134
FOM	$/kW-yr	35.88	36.60	37.33	38.08	38.84	39.62	40.41	41.22	42.04	42.89	43.74	44.62	45.51	46.42	47.35	48.30	49.26
VOM	$/MWh	2.47	2.52	2.57	2.62	2.67	2.73	2.78	2.84	2.89	2.95	3.01	3.07	3.13	3.20	3.26	3.32	3.39
NOx	lb/MMBtu	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
SO2	lb/MMBtu	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
CO2	lb/MMBtu	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30	206.30
NOx	lb/MWh	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
SO2	lb/MWh	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
CO2	T/MWh	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Size	MW	830	830	830	830	830	830	830	830	830	830	830	830	830	830	830	830	830
Capacity Factor	%	91.07%	90.69%	91.10%	91.10%	91.10%	91.07%	90.69%	90.29%	89.93%	88.77%	88.55%	88.04%	87.20%	86.44%	86.25%	86.19%	82.40%
Generation	GWh	6,622	6,594	6,624	6,624	6,624	6,622	6,594	6,565	6,539	6,454	6,438	6,401	6,340	6,285	6,271	6,267	5,991
Capital Cost	$000	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641	336,641
Network Upgrade Cost	$000	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556	27,556
Fuel Cost	$000	119,918	150,922	156,688	161,148	164,894	170,803	180,245	185,637	190,281	193,316	198,878	202,923	206,598	210,473	215,779	221,407	217,426
Fixed O&M	$000	29,784	30,380	30,987	31,607	32,239	32,884	33,542	34,212	34,897	35,595	36,307	37,033	37,773	38,529	39,299	40,085	40,887
Variable O&M	$000	16,358	16,616	17,024	17,364	17,712	18,060	18,345	18,628	18,926	19,055	19,388	19,661	19,863	20,083	20,440	20,836	20,317
NOx	$000	3,972	3,892	3,673	3,765	3,859	4,114	4,362	4,339	4,343	3,976	3,497	3,146	2,820	2,532	2,289	2,074	1,798
SO2	$000	316	829	1,348	1,865	2,381	2,318	2,602	3,054	3,429	3,470	3,548	2,892	2,349	1,909	1,562	1,280	1,004
CO2	$000	0	0	0	139,143	148,035	158,824	169,563	179,683	189,440	197,793	209,031	221,417	236,150	251,905	270,324	290,416	298,346
Total Cost (Mix of Annual+Levelized)	$000	534,545	566,835	573,917	719,089	733,317	751,200	772,856	789,751	805,514	817,301	834,846	851,269	869,751	889,629	913,892	940,295	943,975
40-Year Levelized Cost	$000	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790	839,790
Total Cost (Mix of Annual+Levelized)	$/MWh	81	86	87	109	111	113	117	120	123	127	130	133	137	142	146	150	158

Assumptions & Average Total Costs/MWh

	ATC	K	Fuel	CO_2
2010	$80	$51	$18	$0
2020	$109	$43	$26	$28
2030	$130	$42	$28	$48
2040	$156	$34	$30	$82
~2050	$195	$30	$31	$124

BEI Electric Generation Alternatives Analysis
Table 5 - Coal Technology Cost Summary
Levelized Cost of Advanced Supercritical Pulverized Coal Plant

1	COD (Jan1)	2009
2	Size MW	830
3	Plant Life Years	40
4	Last Year of Service	2048
5	Capital Cost + AFUDC (EOY 2008) $/kW	3276
6	Capital Cost (@ COD) $/kW	3276
7	Network Upgrade Cost (EOY 2009) $/kW	166
8	Network Upgrade Cost (@ COD) $/kW	166
9	Capital Fixed Charge Rate	12.3807%
10	Network Upgrade Fixed Charge Rate	20.0000%
11	Capital Cost Escalation Rate	4%
12	O&M Escalation Rate	2%
13	Long-term NOx Escalation Rate (2031+)	0.00%
14	Long-term SO2 Escalation Rate (2031+)	2.50%
15	Long-term CO2 Escalation Rate (2031+)	7.50%
16	Long-term Fuel Escalation Rate (2031+)	2.60%
17	Discount Rate	8.98%

- The principal drivers of long-run cost of coal-fired power will be:

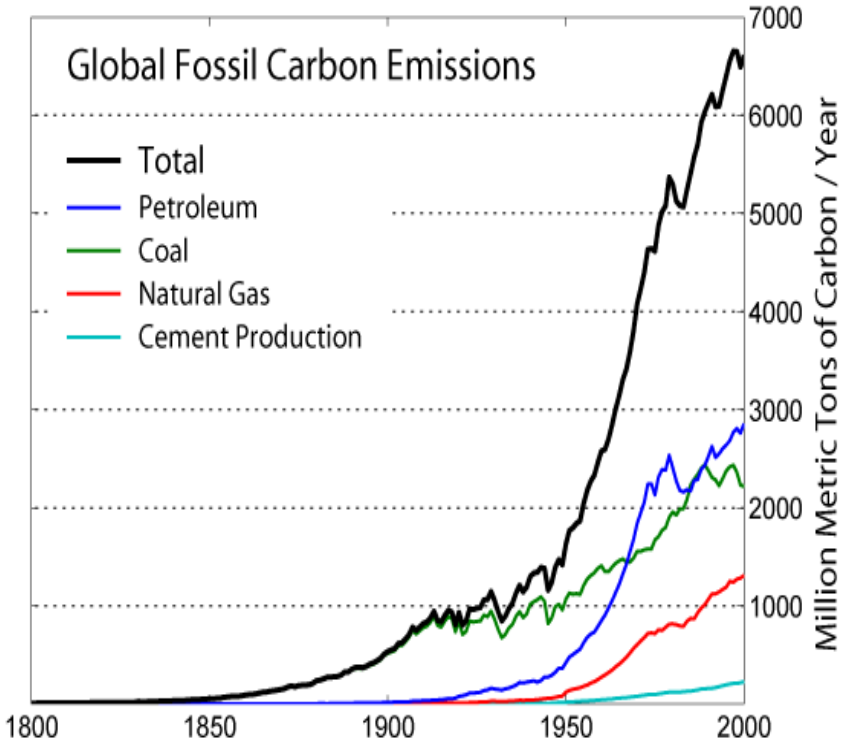
- integration of negative externalities into market prices
- the rate of technological development of alternative sources of renewable power in the forms of both commercial and distributed generation
- the rate of energy efficiency growth

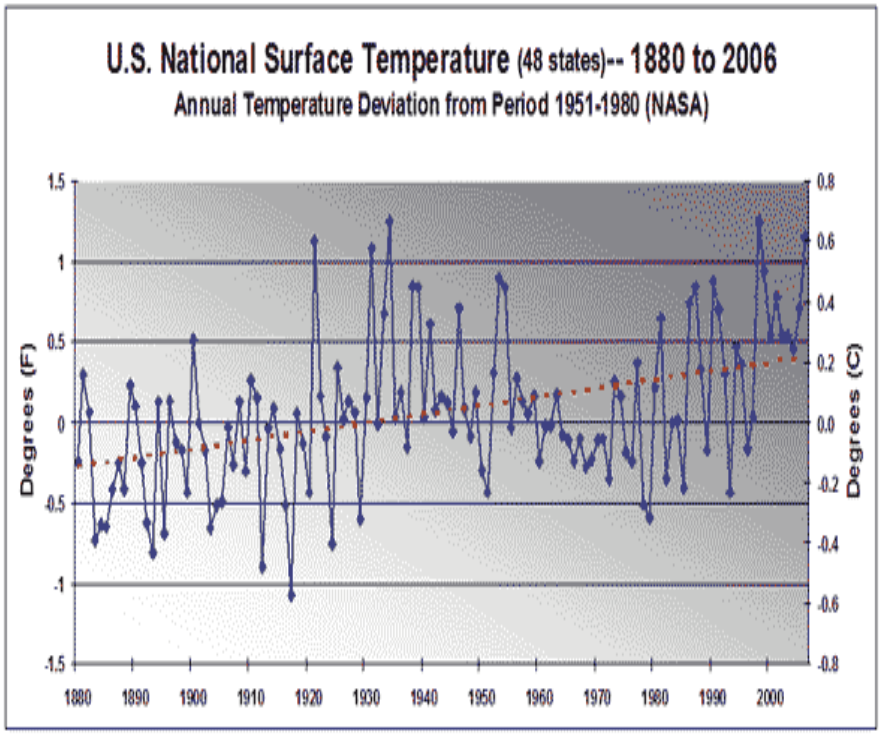
Environmental Costs of Coal-Fired Power

2009 TVA Coal-Ash Spill

Mountain-top Coal Mining

Global Warming ????





Questions & Answers