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Are the U.S. States Equally Prepared for a Carbon Constrained World?

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Motivation

- U.S. energy use and emissions (CO_2) continue to rise
- Future CO_2 reductions seem increasingly likely
- Unlikely to impact the states equally

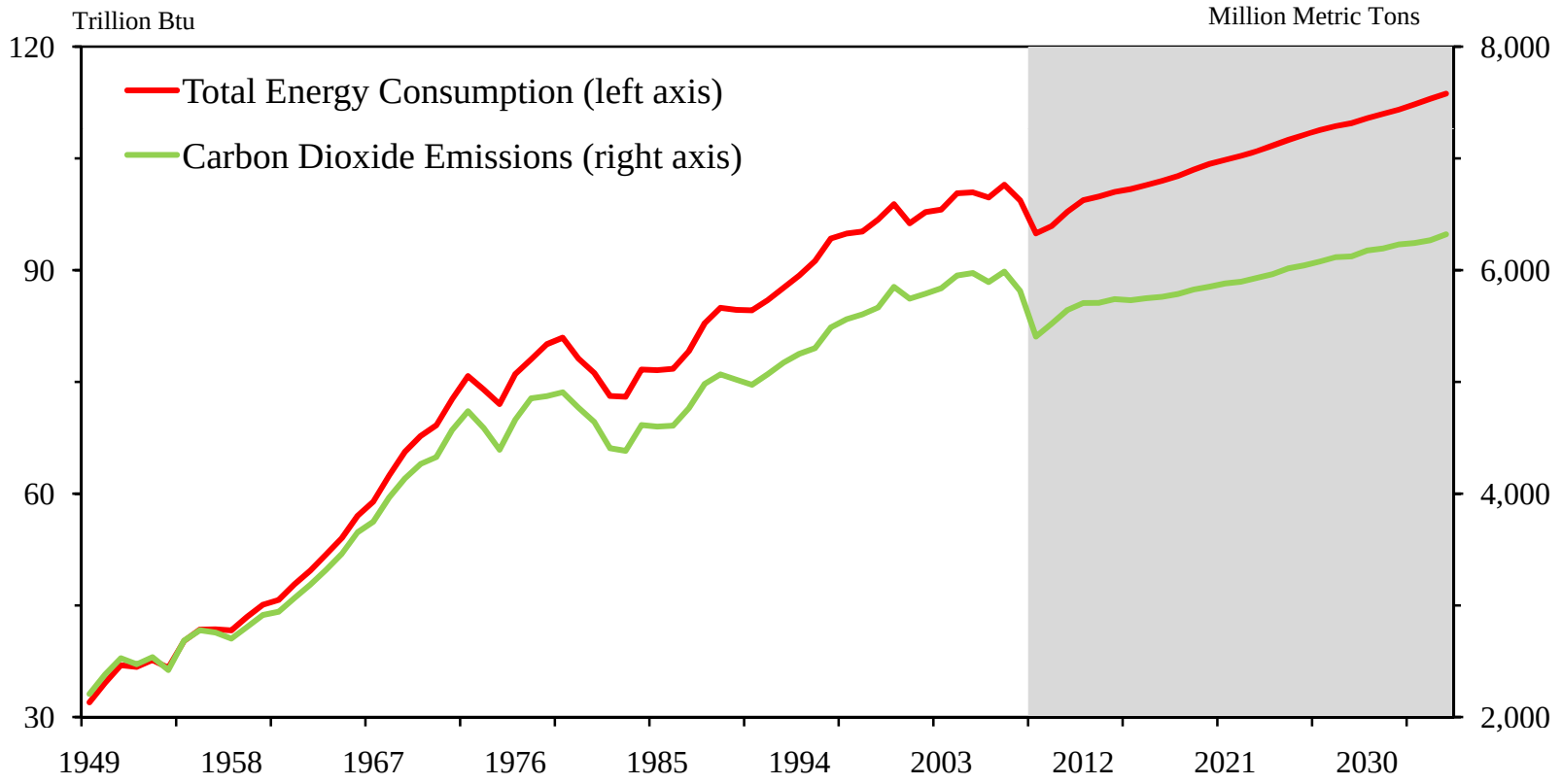
Question: Which states are best/worst positioned to adapt to a carbon constrained world? 10th District states?

Key Findings

- Tremendous variation in energy use and emission patterns across states
- New England and West Coast states are best positioned
- Agriculture and energy states are worst positioned
- 10th Federal Reserve district: 6 of 7 are either energy or ag. States, or both

Entering a third phase of energy use?

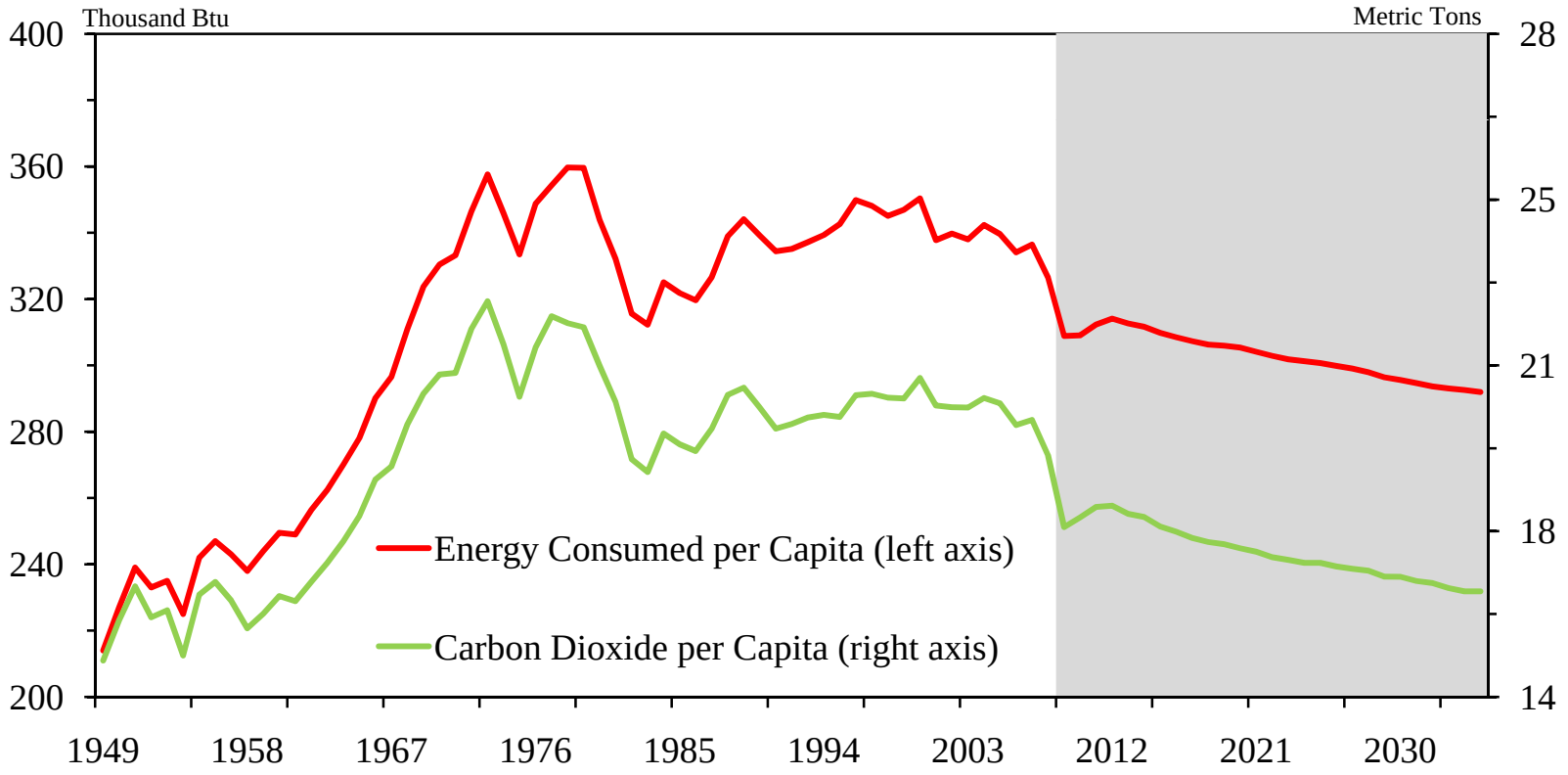
Chart 1:
Total Energy Consumed and Total Carbon Dioxide Emissions - U.S.



Sources: U.S. Department of Energy, Environmental Protection Agency

DOE projecting declining CO_2 emissions per capita

Chart 2:
Energy Consumed and Carbon Dioxide Emissions per Capita - U.S.



Sources: U.S. Department of Energy, Environmental Protection Agency, Bureau of Economic Analysis

Kaya Identity: relates CO_2 to demographics, economic growth, and energy use patterns

$$C = P * (G/P) * (E/G) * (C/E)$$

where,

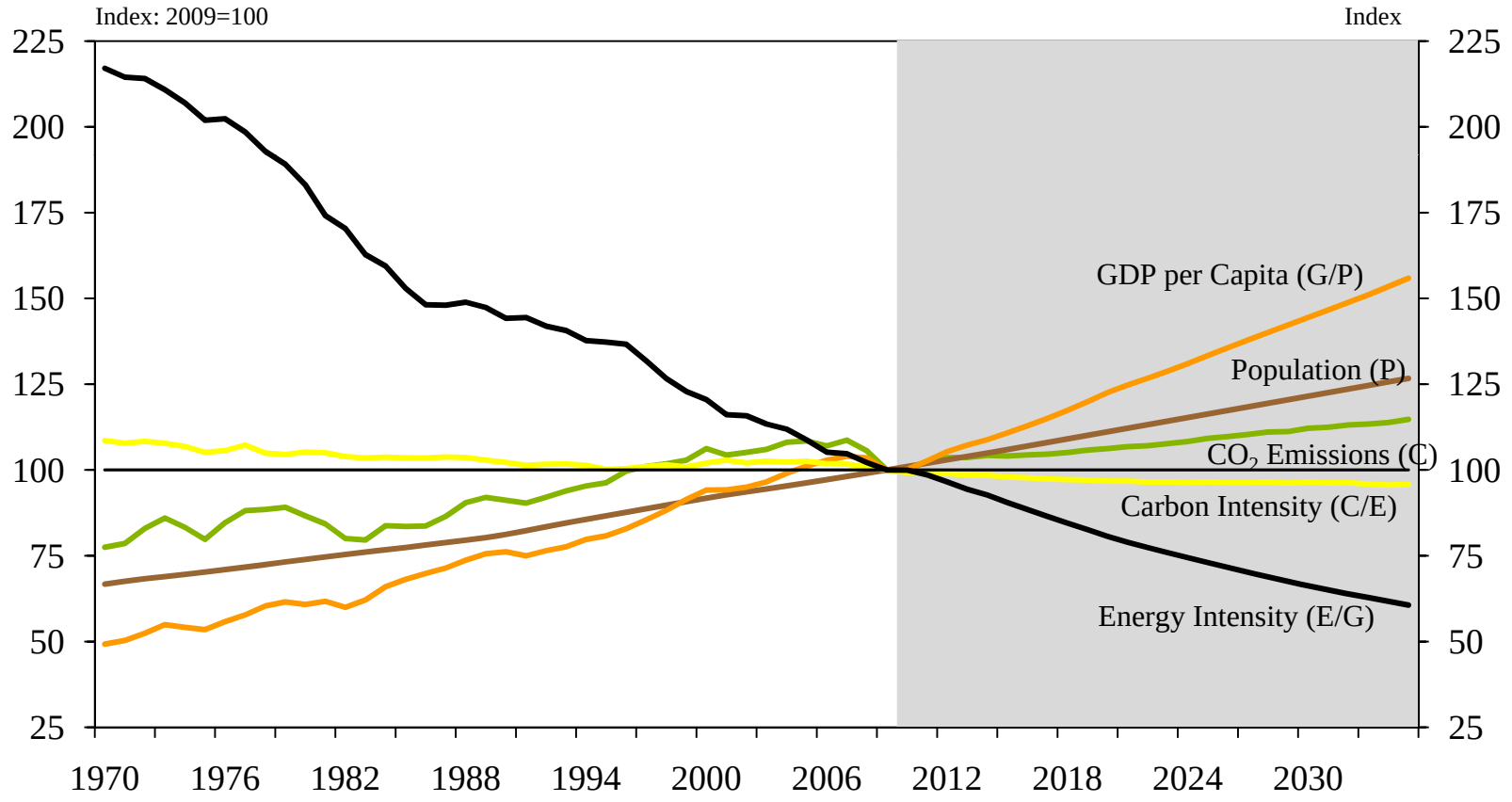
- C = CO_2 emissions from human sources
- P = population
- G = real gross domestic product (GDP)
- E = primary energy consumption
- G/P = real GDP per capita
- E/G = energy intensity of real GDP
- C/E = carbon intensity of energy

use,

$$(C/P) = (G/P) * (E/G) * (C/E)$$

CO_2: GDP and population growth vs. carbon intensity and energy intensity

Chart 3:
Kaya Identity Components - U.S.



Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency

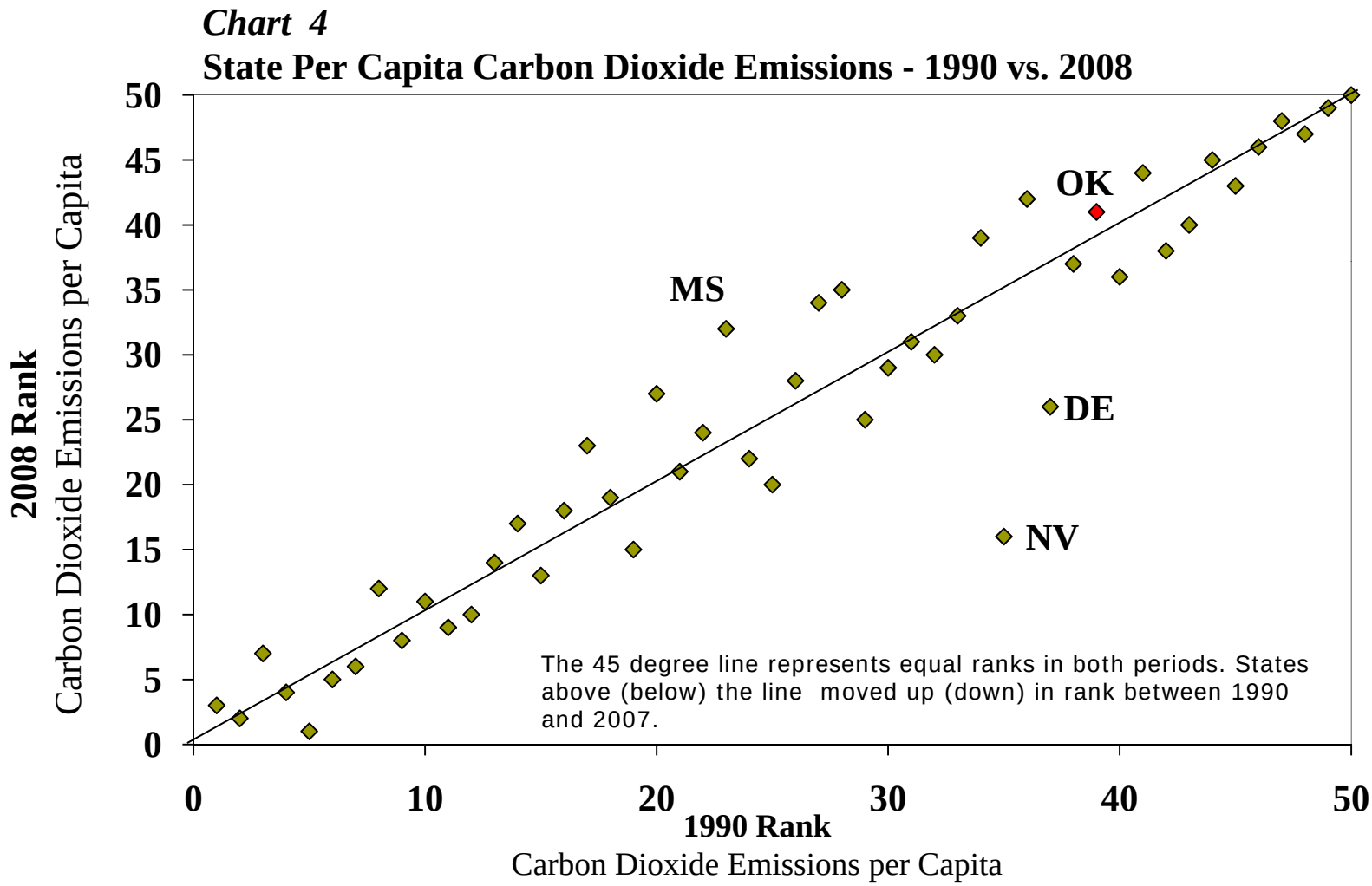
Table 1: Kaya Identity Components - Stave-Level Summary (2008)

State	**Kaya Identity** (C/P) = (G/P) * (E/G) * (C/E)							
	Carbon Dioxide Emissions (*) per Capita (C/P)		**GDP per Capita (G/P)**		**Energy Intensity of Economic Activity (E/G)**		**Carbon Intensity of Energy (C/E)**	
	Metric Tons	Rank	Thousands of 2005 Dollars	Rank	Btu per 2005 Dollar of GDP	Rank	Metric Tons per Million Btu	Rank
New York	10.3	**1**	58.79	5	3.5	1	50.5	10
Vermont	10.4	**2**	40.97	31	6.1	14	42.0	5
Rhode Island	10.5	**3**	44.96	24	4.6	6	50.4	9
Idaho	10.7	**4**	34.53	47	10.0	36	30.8	1
California	11.0	**5**	50.48	9	4.5	5	48.1	7
Connecticut	11.5	**6**	61.71	4	3.7	2	49.7	8
Oregon	11.5	**7**	42.71	29	6.8	20	39.4	3
Massachusetts	12.2	**8**	55.78	6	4.0	3	54.2	16
Washington	12.6	**9**	49.16	17	6.3	17	40.3	4
Maryland	13.8	**10**	48.30	19	5.3	9	53.9	15
Florida	13.9	**11**	40.39	34	6.0	12	57.6	25
New Hampshire	14.4	**12**	45.39	22	5.2	8	61.1	31
Maine	15.1	**13**	37.67	42	9.4	33	42.5	6
New Jersey	15.5	**14**	54.82	7	5.6	10	50.9	13
Arizona	15.6	**15**	38.29	40	6.2	15	65.4	33
Nevada	15.9	**16**	50.17	13	5.7	11	55.5	17

Table 1: Kaya Identity Components – *Continued*

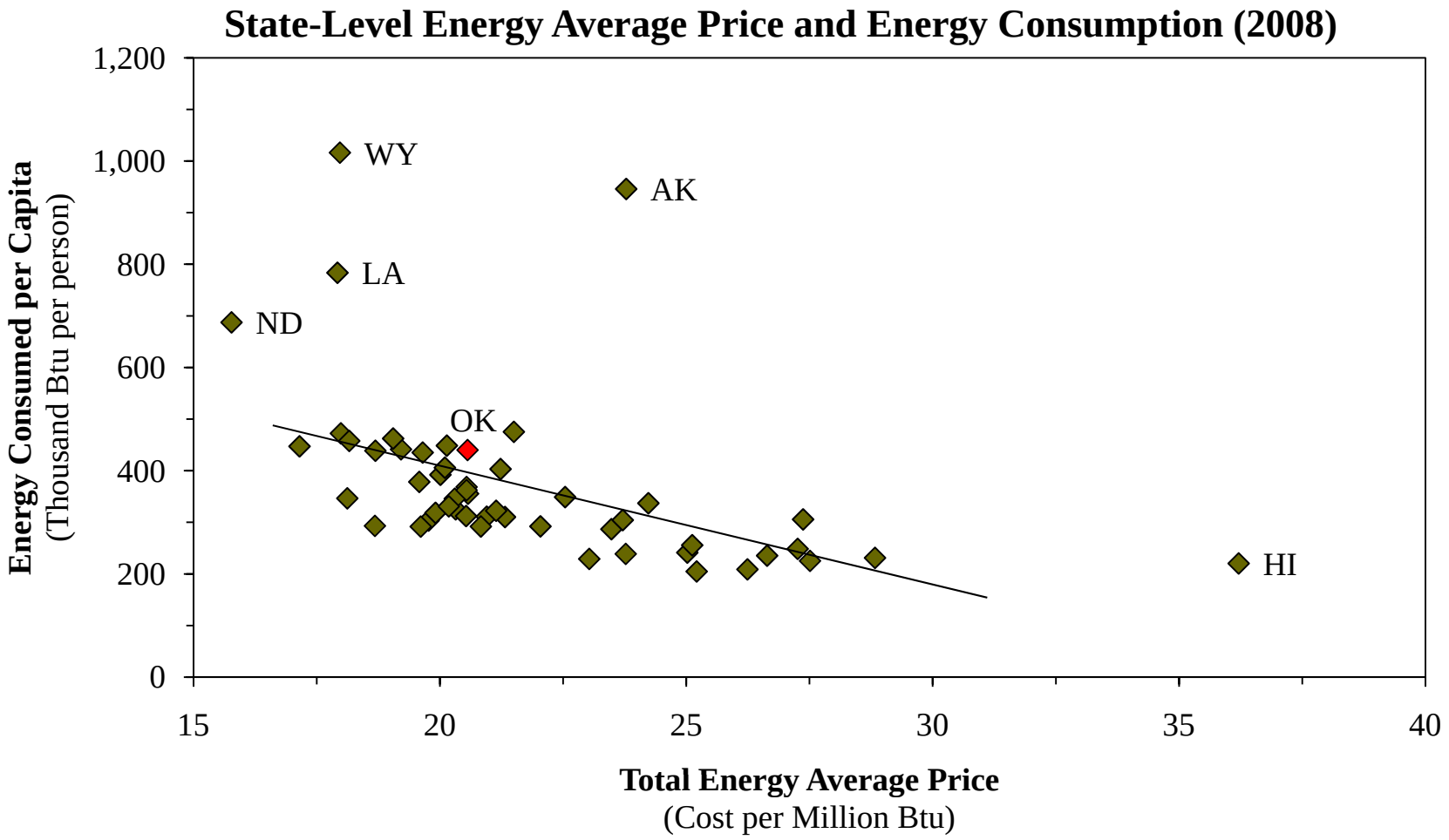
State	**Kaya Identity** (C/P) = (G/P) * (E/G) * (C/E)							
	Carbon Dioxide Emissions (*) per Capita (C/P)		**GDP per Capita (G/P)**		**Energy Intensity of Economic Activity (E/G)**		**Carbon Intensity of Energy (C/E)**	
	Metric Tons	Rank	Thousands of 2005 Dollars	Rank	Btu per 2005 Dollar of GDP	Rank	Metric Tons per Million Btu	Rank
Missouri	23.5	**34**	39.92	38	8.1	27	72.3	41
Nebraska	24.6	**35**	46.73	20	9.4	32	56.1	20
Utah	25.4	**36**	40.25	35	7.3	22	86.6	46
Texas	27.8	**37**	50.34	11	9.4	34	58.6	26
Kansas	28.1	**38**	43.87	26	9.3	31	69.1	38
Iowa	28.5	**39**	45.32	23	10.4	37	60.2	29
New Mexico	29.5	**40**	40.22	36	8.7	29	84.5	44
Oklahoma	30.0	**41**	40.19	37	11.0	39	68.2	37
Alabama	31.1	**42**	36.35	45	12.1	43	70.3	39
Indiana	36.1	**43**	39.89	39	11.2	40	80.8	43
Kentucky	36.6	**44**	36.48	44	12.7	44	79.1	42
Montana	38.9	**45**	37.08	43	12.1	42	86.8	47
Louisiana	43.8	**46**	49.92	14	15.7	50	55.9	18
Alaska	62.7	**47**	69.63	2	13.6	47	66.3	35
West Virginia	64.1	**48**	33.97	49	13.5	46	140.1	50
North Dakota	76.4	**49**	48.65	18	14.1	48	111.1	48
Wyoming	121.2	**50**	66.25	3	15.3	49	119.2	49
Tenth District	27.4		34.74		10.9		72.4	
United States	**19.7**		**46.54**		**7.0**		**60.2**	

Very little change in the ranks since 1990 based on carbon emissions per capita



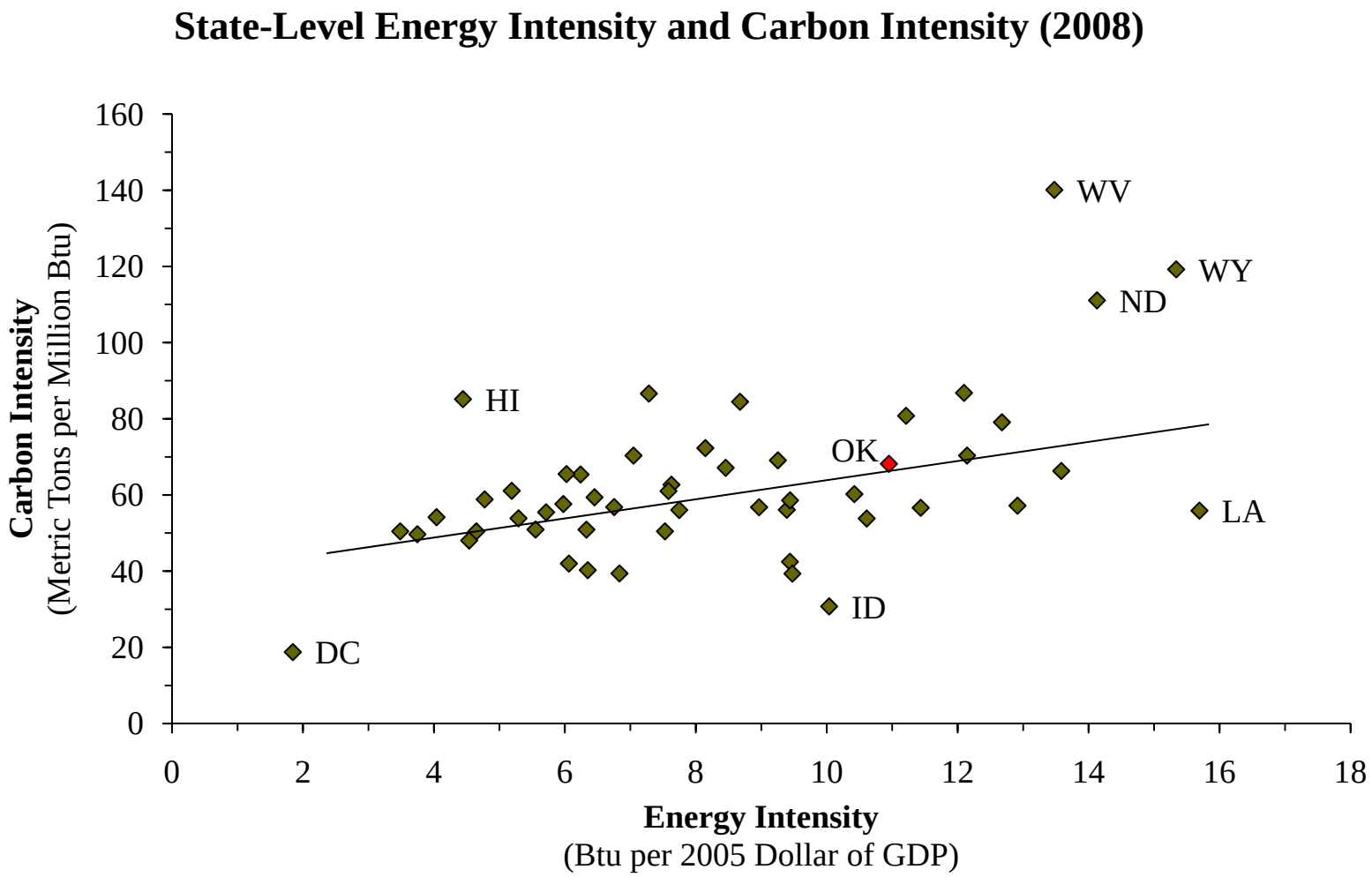
Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency

High carbon states generally have lower energy prices on average



Sources: U.S. Department of Energy, Bureau of Economic Analysis

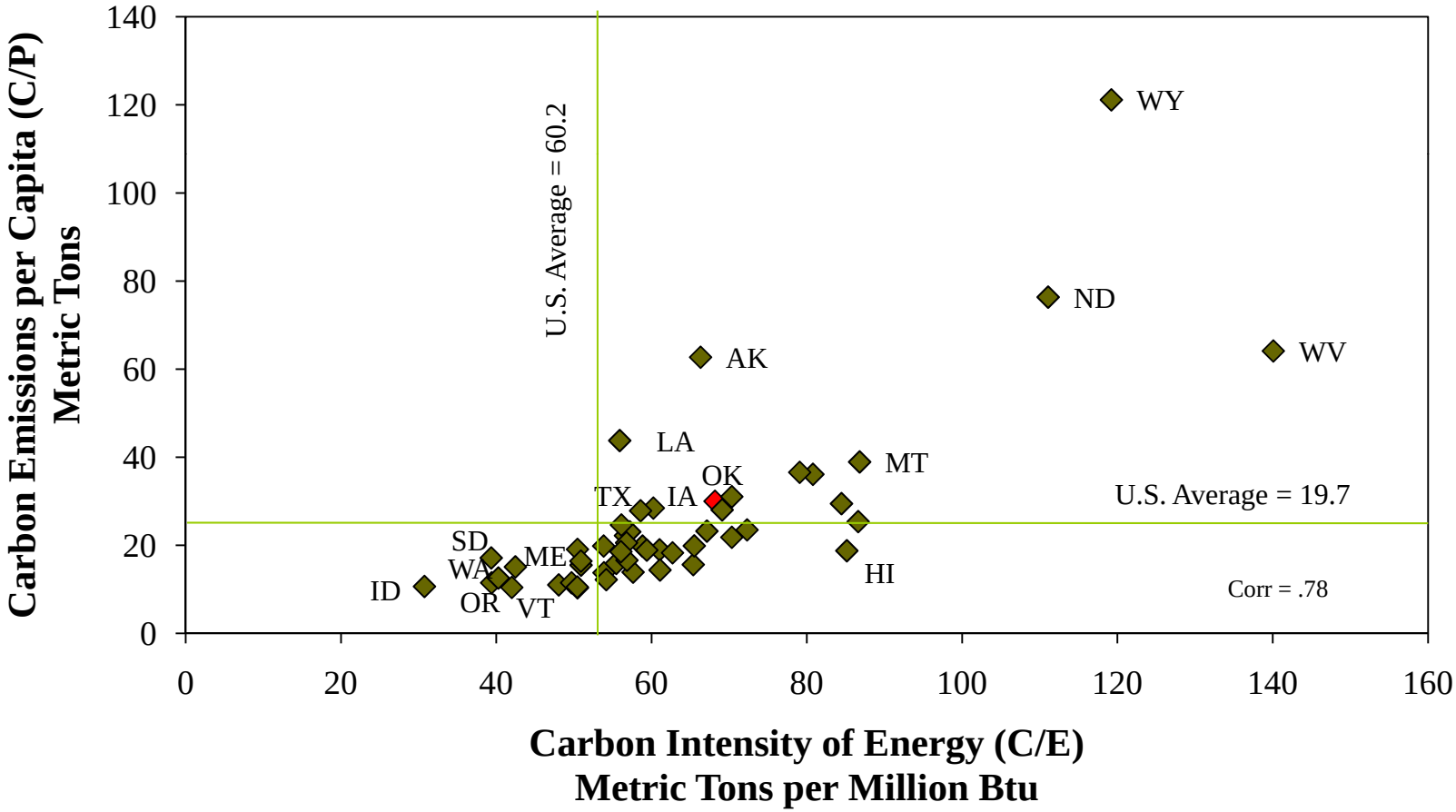
States ‘tend’ to be both carbon intensive and energy intensive



Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency

Carbon intensity is more consistent across states

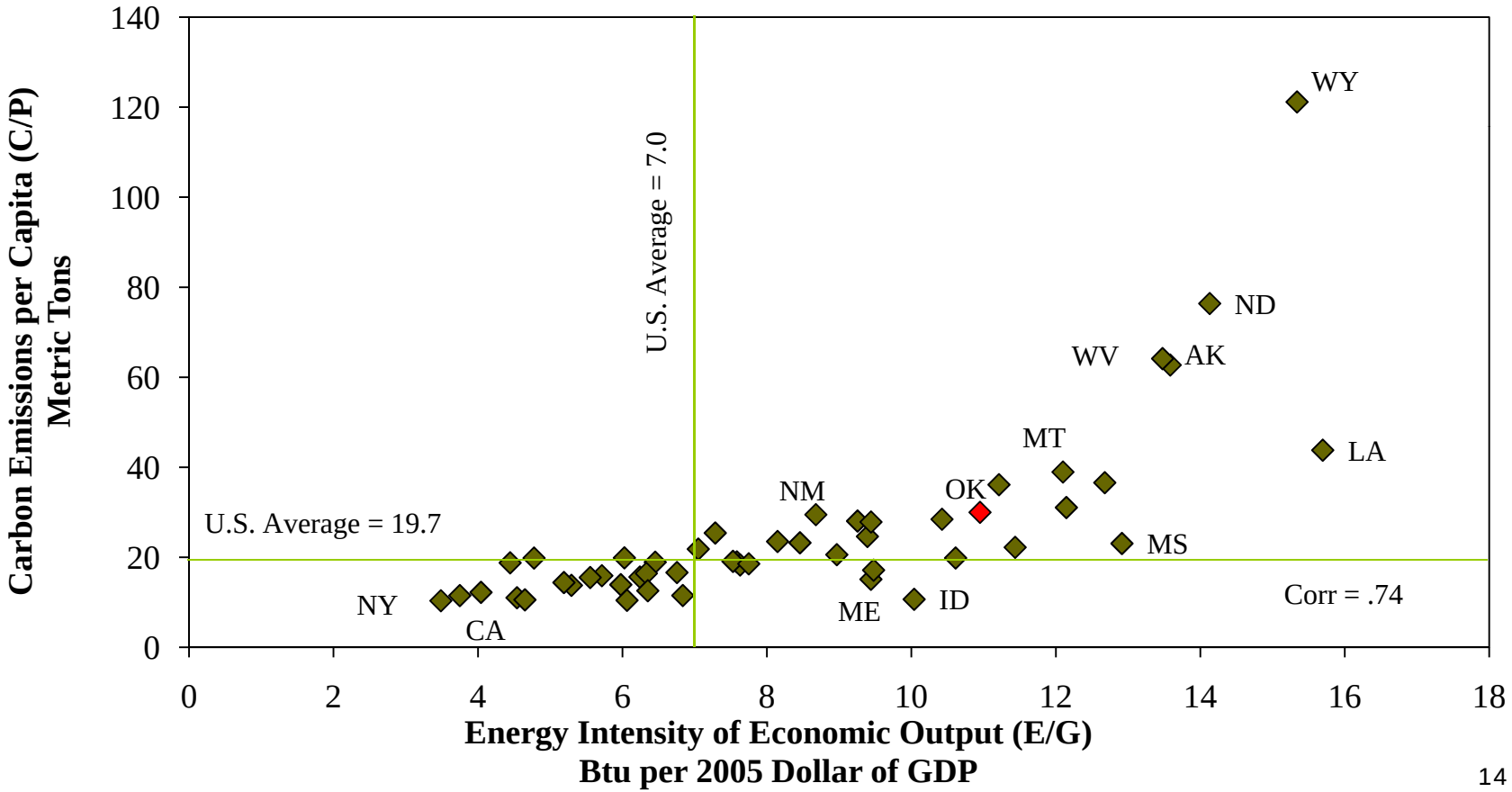
Chart B2:
State Carbon Emissions per Capita and Carbon Intensity



Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency

Greater variation in energy intensity across states

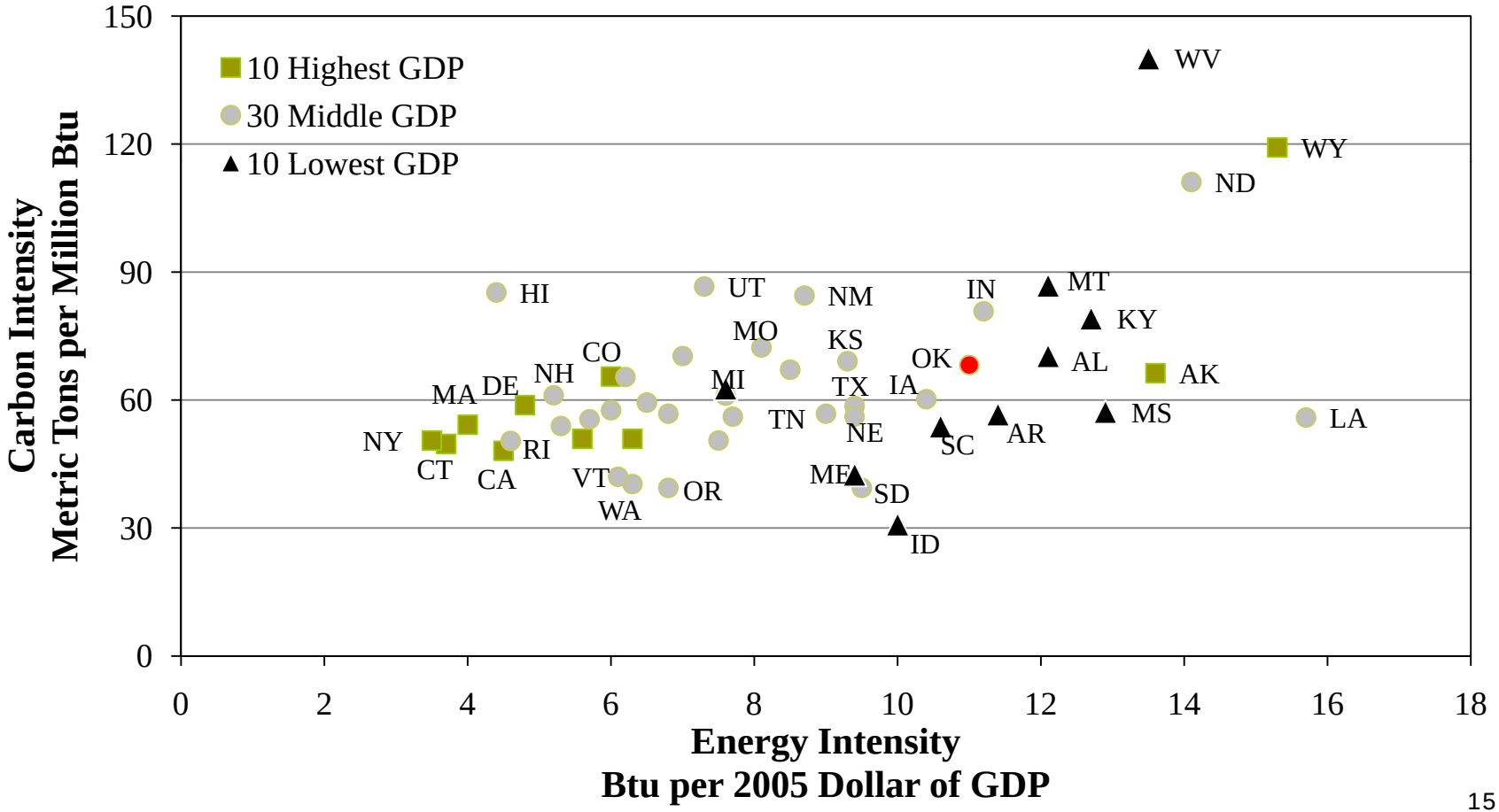
Chart B1:
State per Capita Carbon Emissions and Energy Intensity



Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency

GDP level explains much of the energy use pattern

Chart 5:
Energy Intensity and Carbon Intensity by GDP per Capita (2008)



Energy and Carbon Intensity by GDP level

Table 2:

State Energy and Carbon Intensity by Level of GDP per Capita

Level of GDP	Mean		Median	
	Energy Intensity of Economic Activity (E/G)	**Carbon Intensity of Energy (C/E)**	**Energy Intensity of Economic Activity (E/G)**	**Carbon Intensity of Energy (C/E)**
	Btu per 2005 Dollar of GDP	Metric Tons per Million Btu	Btu per 2005 Dollar of GDP	Metric Tons per Million Btu
10 Highest GDP	6.9	61.7	5.6	50.9
30 Middle GDP	8.0	62.4	7.6	59.0
10 Lowest GDP	11.2	68.0	11.8	60.0

NM leads the 10th District in recent CO_2 reduction

OK has sharpest increase in carbon intensity

Table B1: Kaya Identity Components for the Tenth District States

State	Carbon Dioxide Emissions	Total Energy Consumed	Kaya Identity Percent Change (1990-2007)			
			Carbon Dioxide Emissions per Capita (C/P)	**Real GDP per Capita (G/P)**	**Energy Intensity of Economic Activity (E/G)**	**Carbon Intensity of Energy (C/E)**
	Million Metric Tons	Billion Btu	Metric Tons	Thousands of 2005 Dollars	Btu per 2005 Dollar of GDP	Metric Tons per Million Btu
Colorado	47.1	60.9	0.5	47.5	-25.5	-8.6
Kansas	12.8	9.0	0.8	37.6	-29.2	3.5
Missouri	35.2	29.7	17.3	29.7	-13.2	4.2
Nebraska	32.4	42.5	18.3	45.8	-12.7	-7.1
New Mexico	**11.4**	**18.7**	**-13.9**	**61.9**	**-43.3**	**-6.2**
Oklahoma	23.2	15.6	7.4	29.7	-22.3	6.6
Wyoming	11.8	30.4	-3.1	18.9	-5.0	-14.2
10th District	25.6	27.8	3.4	38.9	-24.2	-1.7
United States	**19.2**	**19.8**	**-1.3**	**36.4**	**-27.3**	**-0.5**

Sources: U.S. Department of Energy, Bureau of Economic Analysis, Environmental Protection Agency, and authors' calculations.

Carbon Constrained World

Full paper is available online at:

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