The Shape of Things to Come: Incorporating Unproven Reserves of Efficiency Savings into Energy Models

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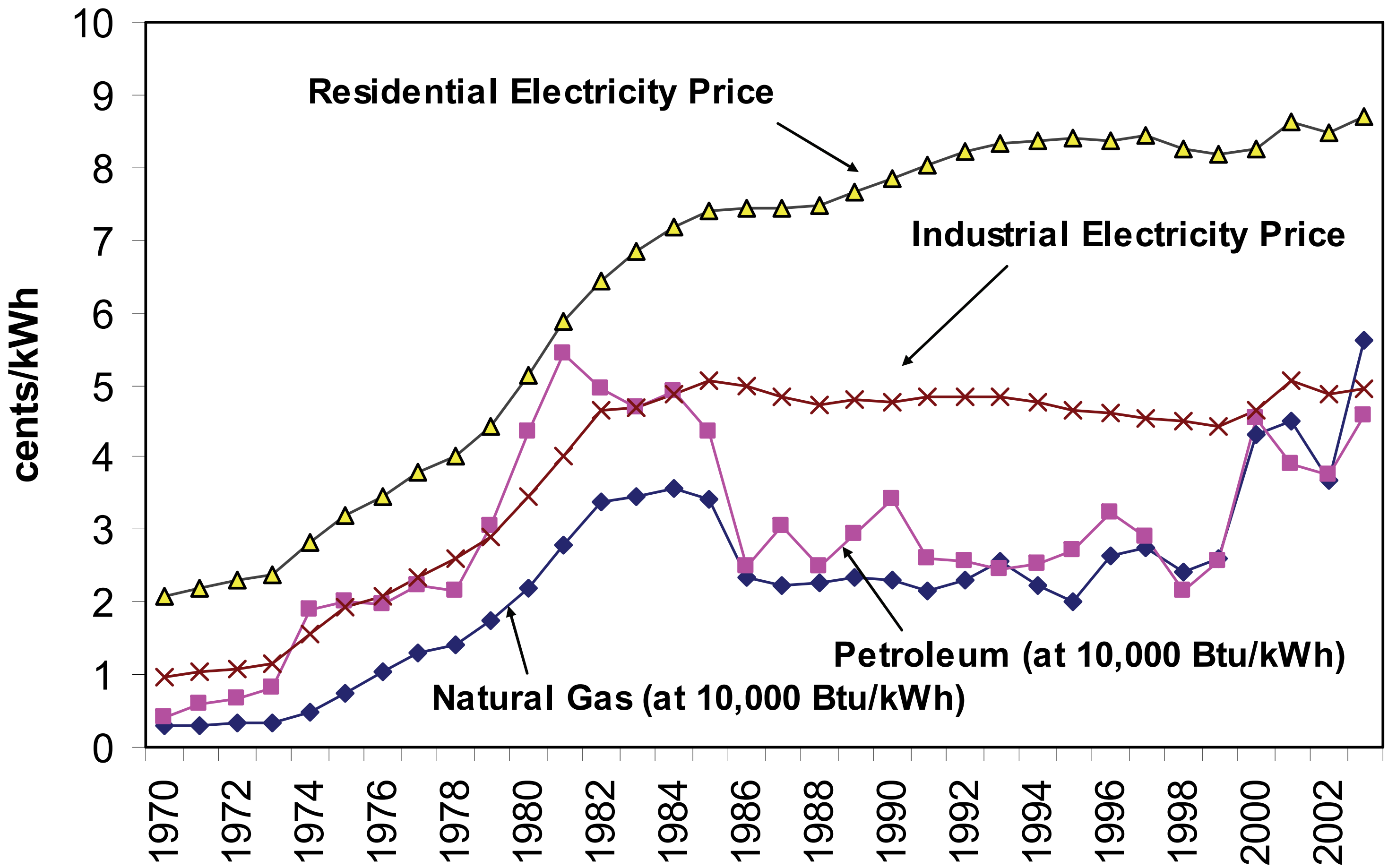
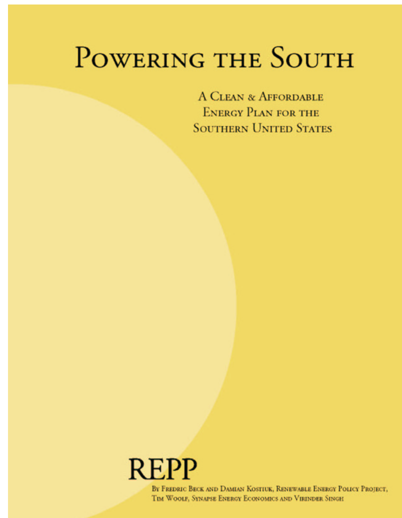
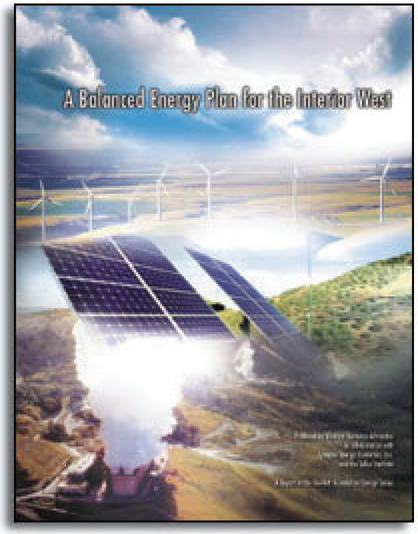
1. Marginal costs influence behavior
2. The shape of CSE curves matters
3. Unproven efficiency reserves are typically ignored
4. Unproven oil and gas reserves are not ignored
5. Research is needed to characterize technological change and unproven efficiency reserves

Prices for US Electricity, Gas, Oil (nominal $)



Regional Clean Energy Plans

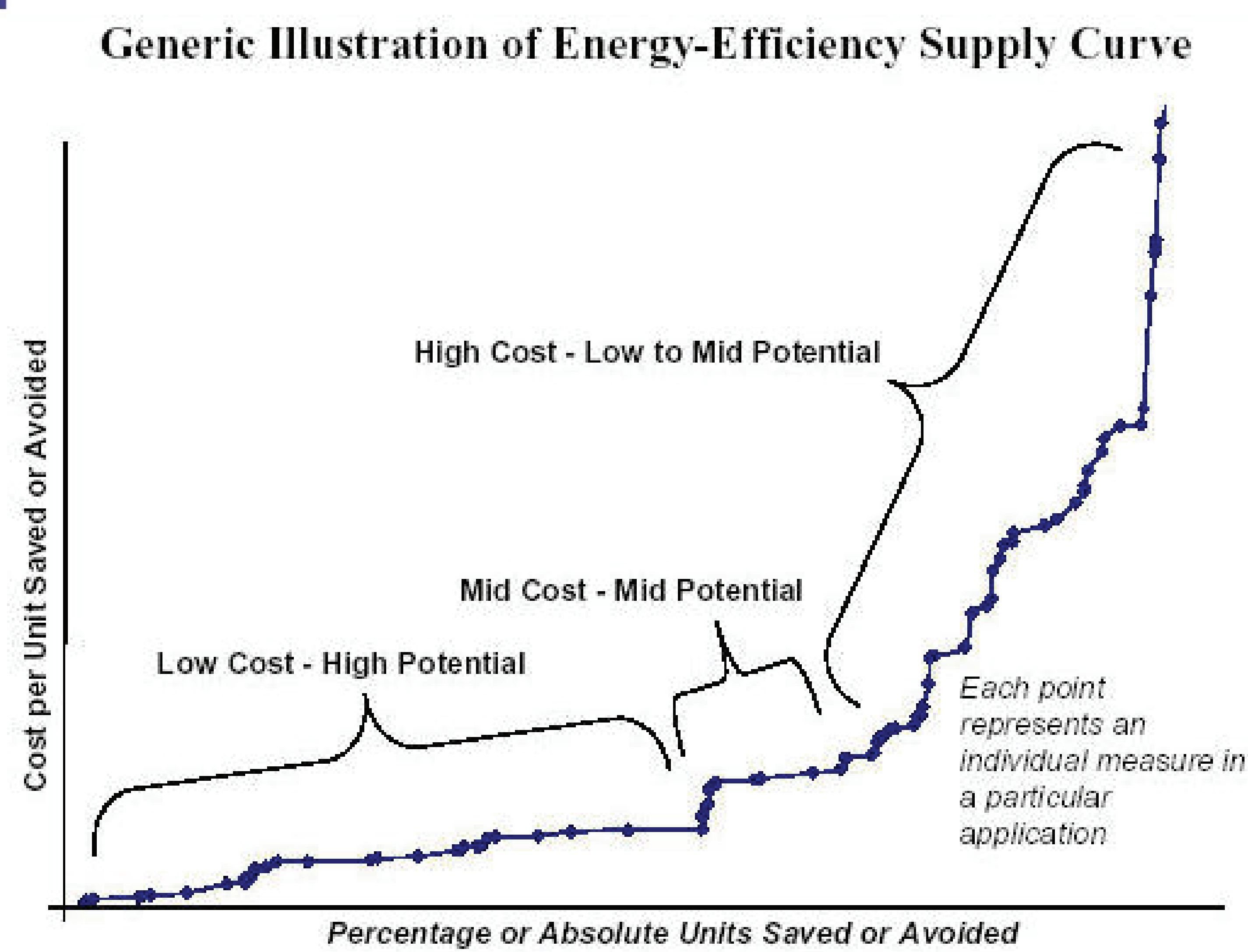




These reports are available on the web:

- www.repowermidwest.org
- www.poweringthesouth.org
- www.westernresourceadvocates.org/energy/bep.html

Xenergy, Generic curve



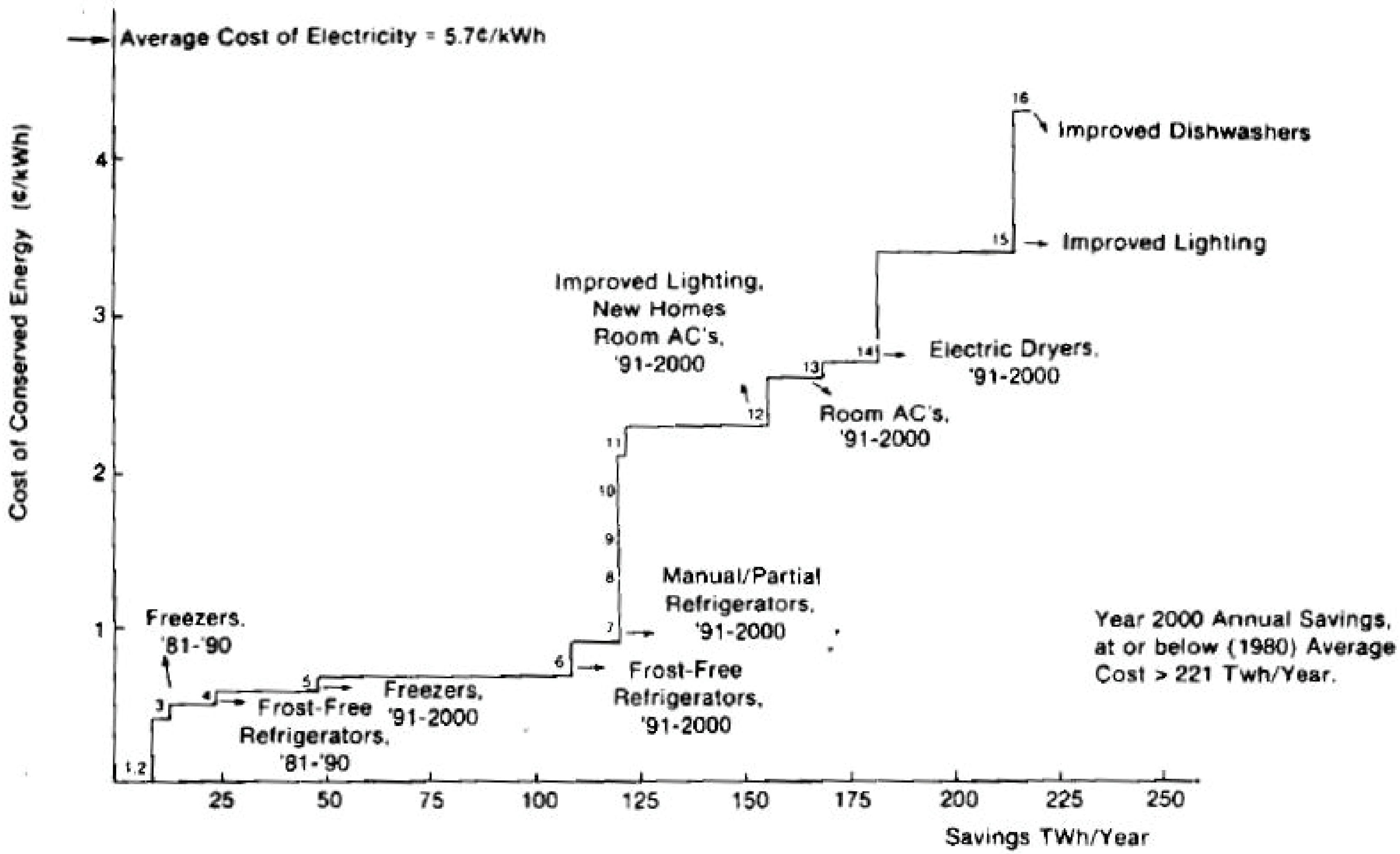
CSE Curve Data

- **Xenergy, Generic curve**
- **Solar Energy Research Institute, 1981, US**
- **Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies, 1997, US**
- **Tellus, 2002, Pacific NW**
- **American Council For an Energy-Efficient Economy, 1989, New York State (4)**
- **Marbek Resource Consultants and Willis Energy Services, 2003, British Columbia (2)**
- **LBL, 1999, US**
- **SERI, 1981, US**

CSE Curve Data

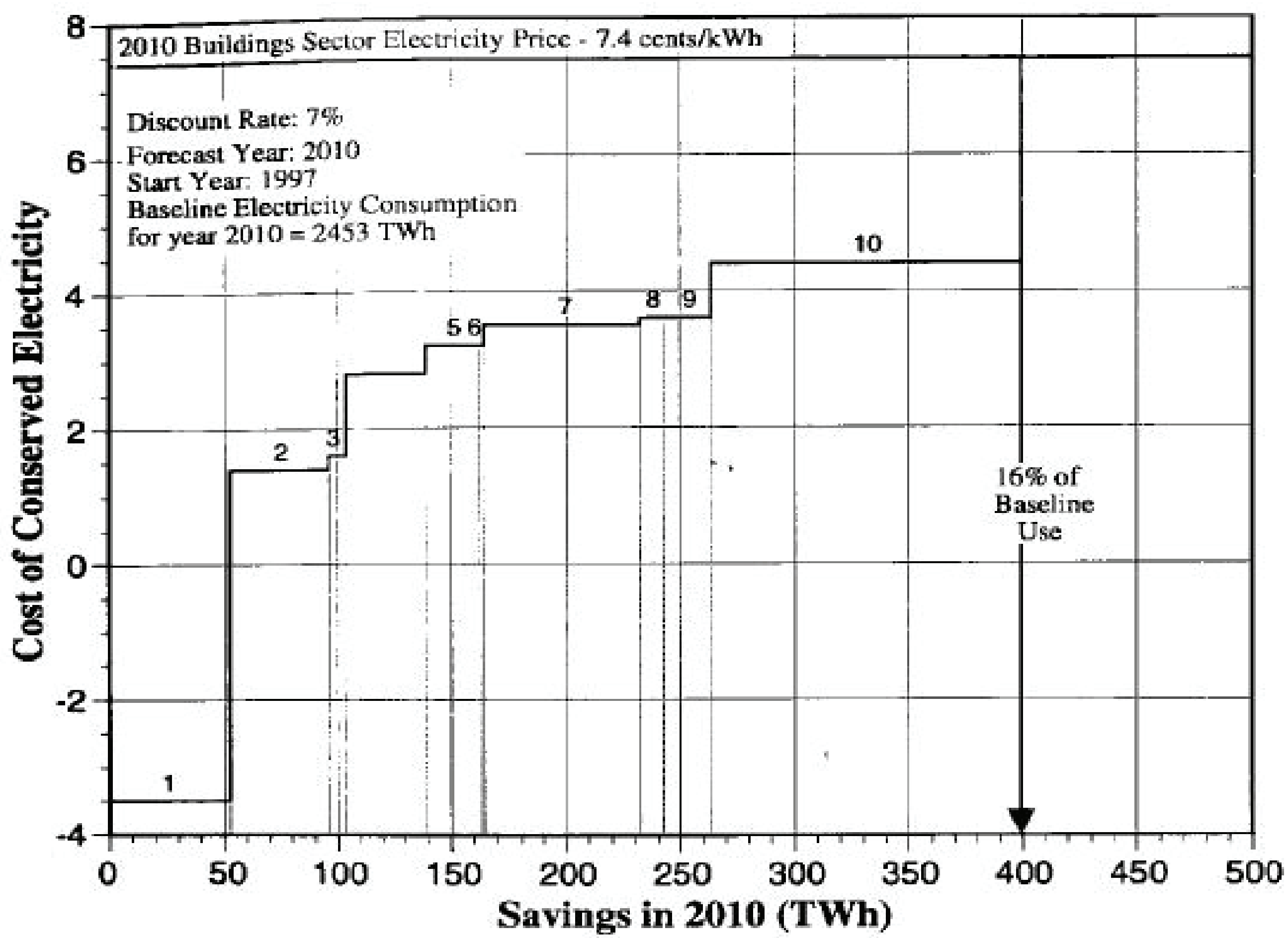
- LBL, 1995, US
- Amory Lovins, 1989, US
- Optimal, 2003, New York State
- Xenergy, 2002, California
- Hewlett Energy Foundation, 2002, California
- Northwest Power and Conservation Council, 2002, Pacific NW
- Tellus, 2001, Interior West
- Tellus, 2001, Pacific NW
- Tellus, 2001, Utah
- NYSERDA, 2003, New York State (2)

Solar Energy Research Institute, 1981, US

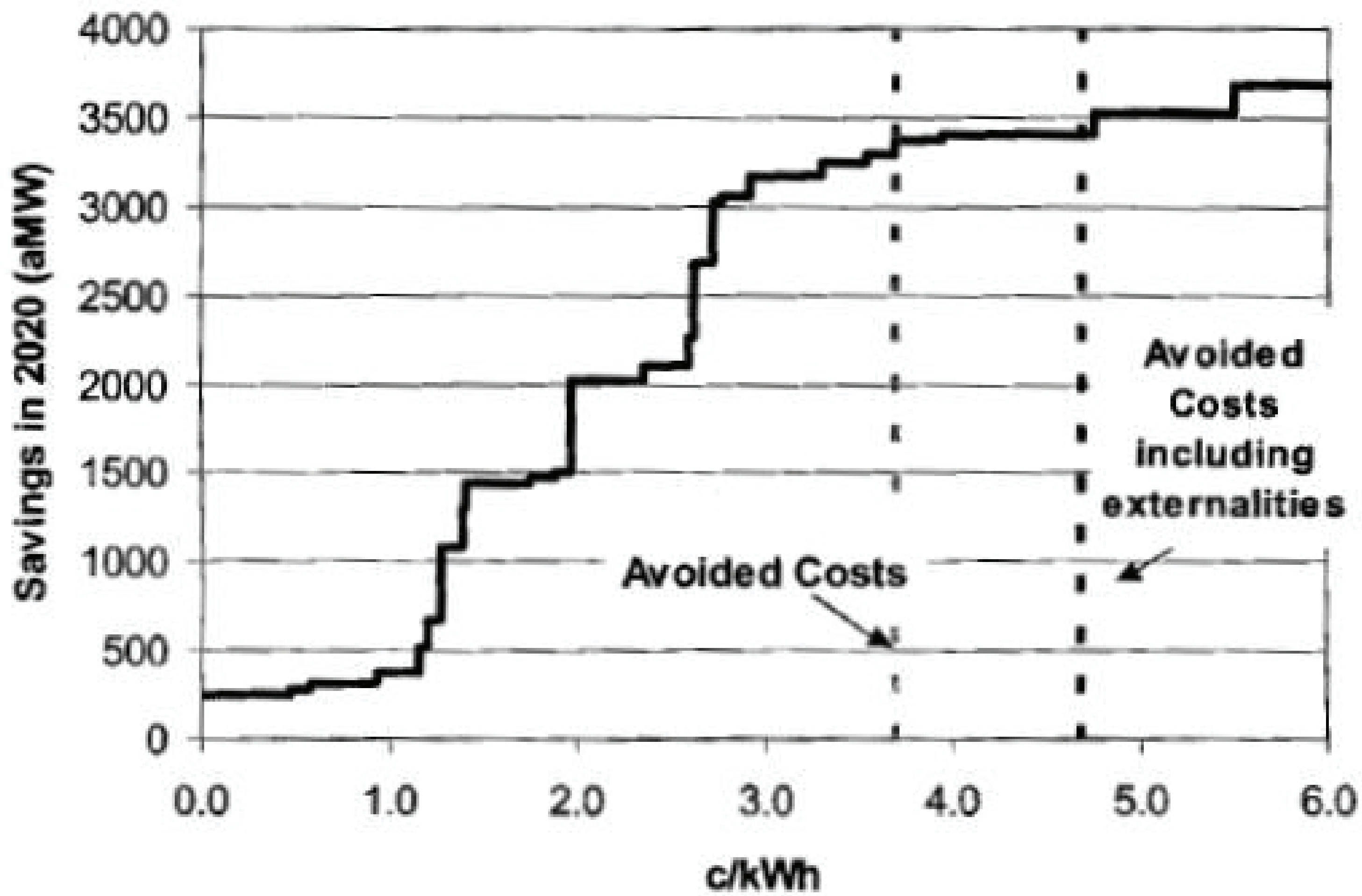


Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies, 1997, US

Figure 3.6 Electricity Supply Curve By End-Use for Buildings in 2010, High-Efficiency/Low-Carbon Case

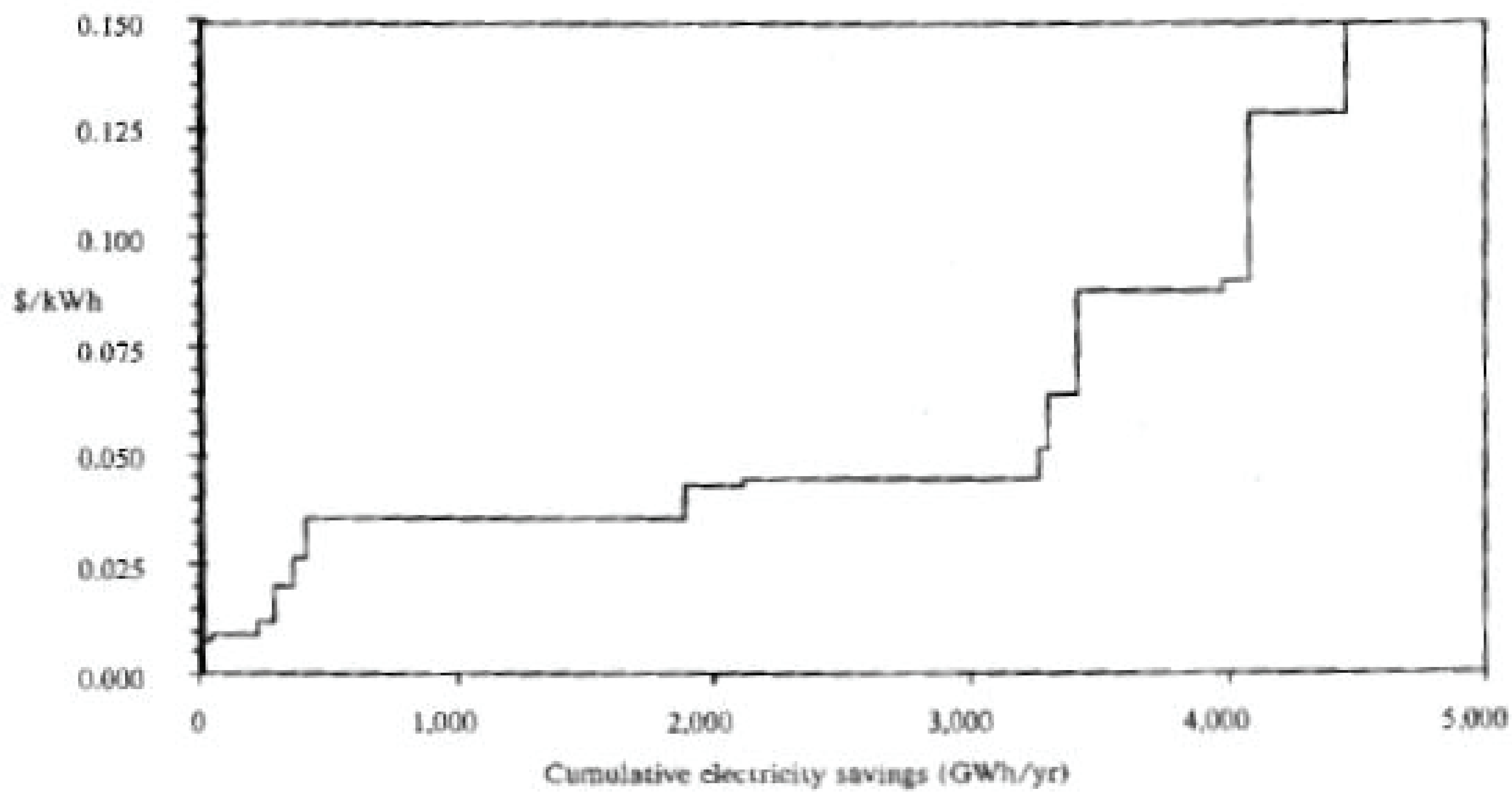


Tellus, 2002, Pacific NW



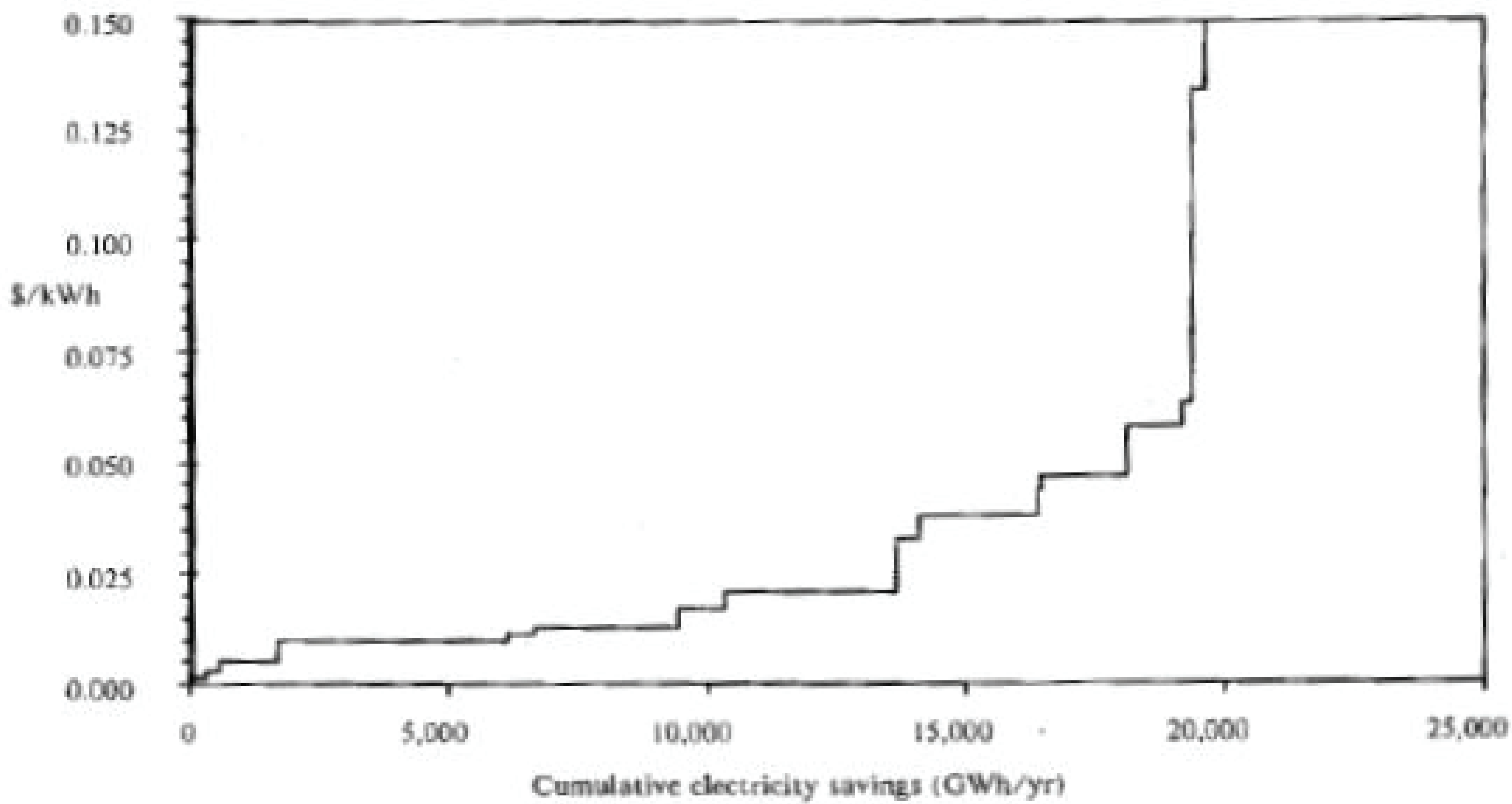
American Council For an Energy-Efficient Economy, 1989, New York State

ELECTRICITY CONSERVATION SUPPLY CURVE – INDUSTRIAL SECTOR
New York State – 6% Discount Rate

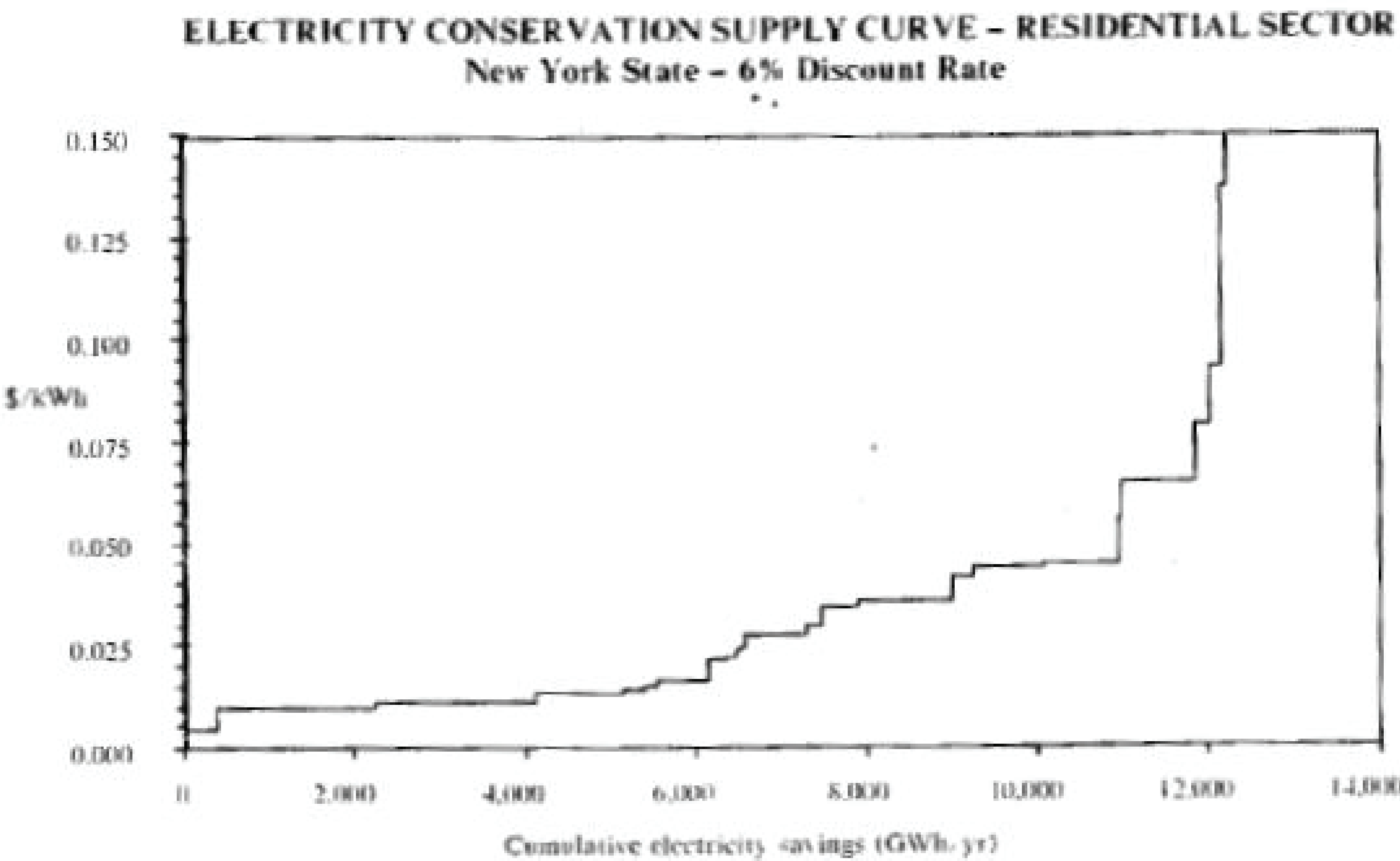


American Council For an Energy-Efficient Economy, 1989, New York State

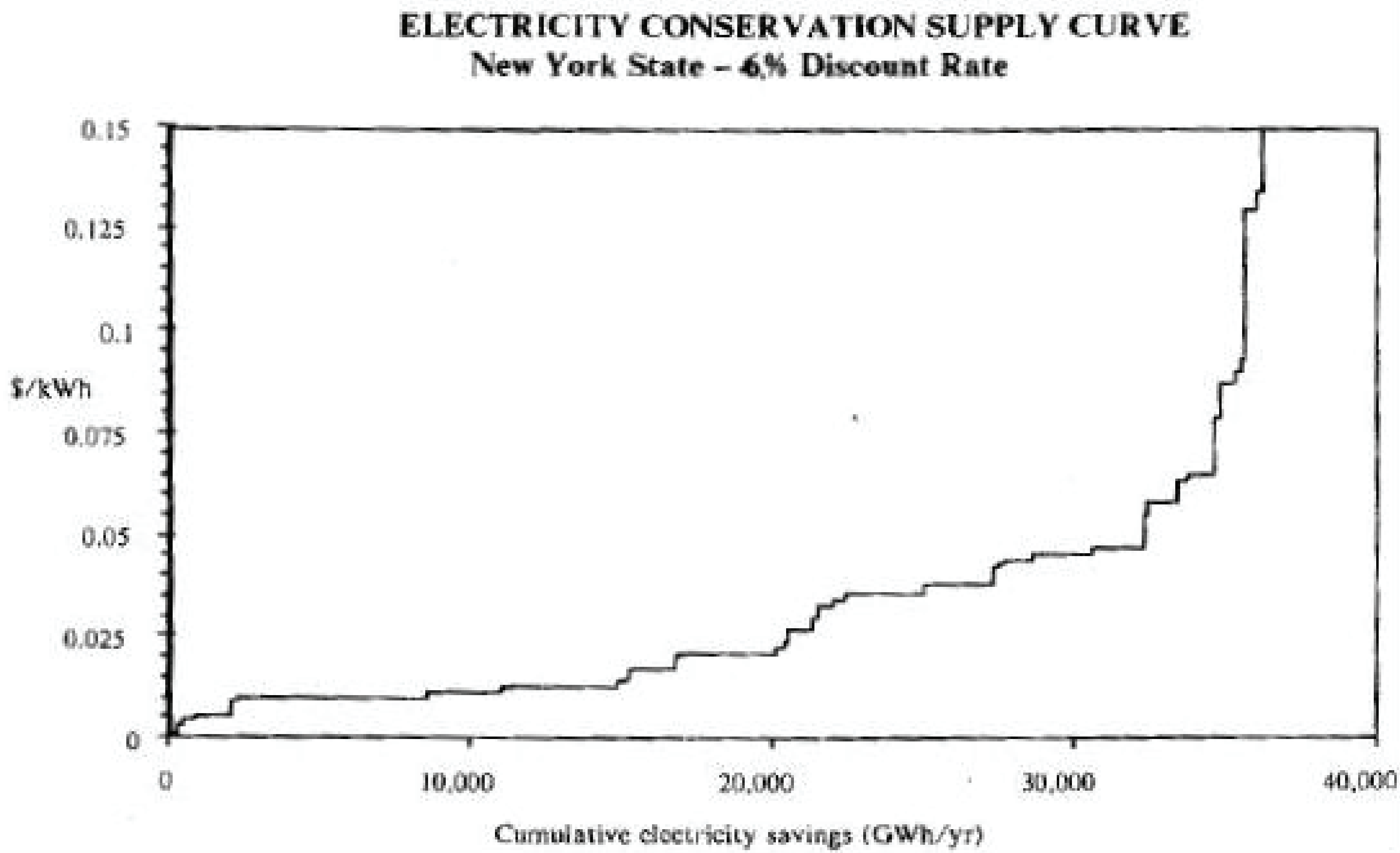
ELECTRICITY CONSERVATION SUPPLY CURVE – COMMERCIAL SECTOR
New York State – 6% Discount Rate



American Council For an Energy-Efficient Economy, 1989, New York State



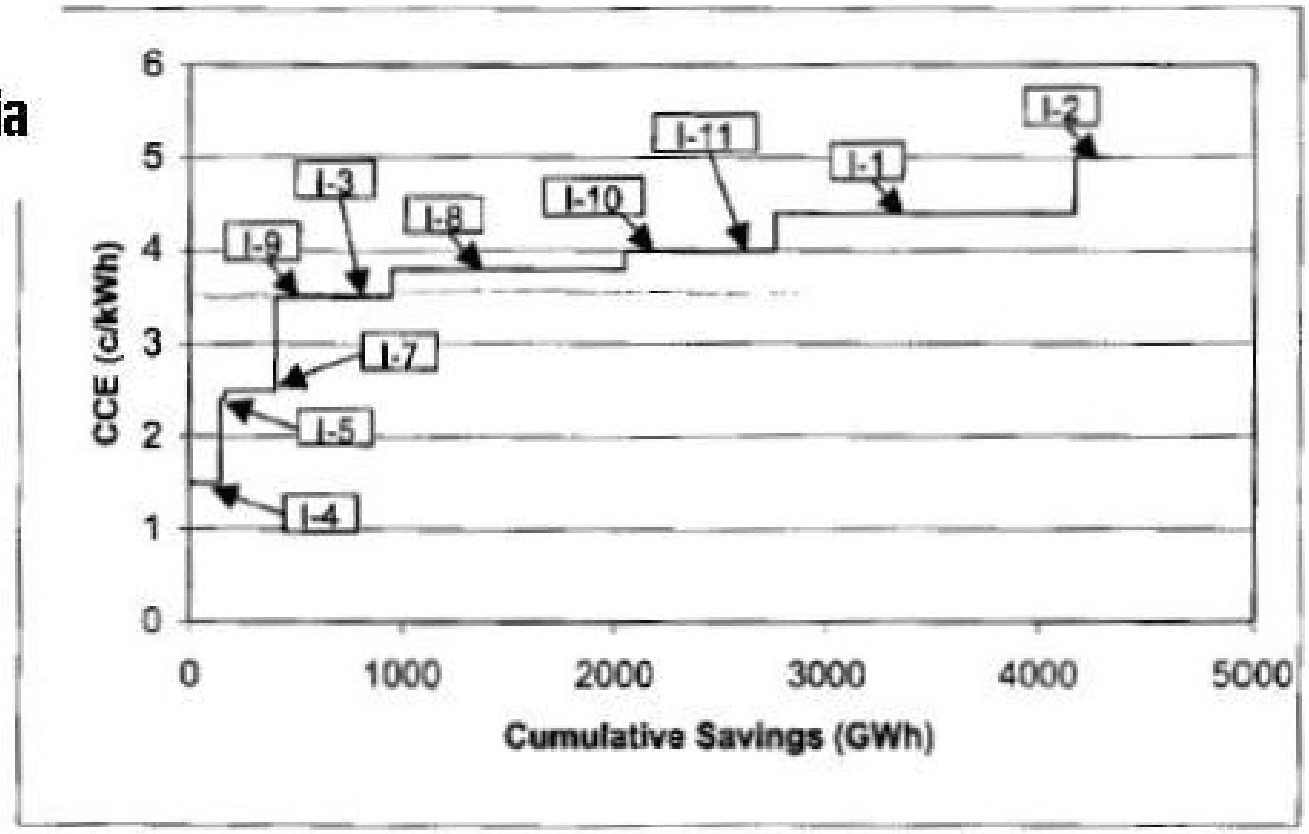
American Council For an Energy-Efficient Economy, 1989, New York State



Marbek Resource Consultants and Willis Energy Services, 2003, British Columbia

Exhibit 6.13: Supply Curve of Industrial Sector Actions—Cumulative Electricity Savings in the Milestone Year of 2015/16 for Upper Scenario, (GWh/yr.)

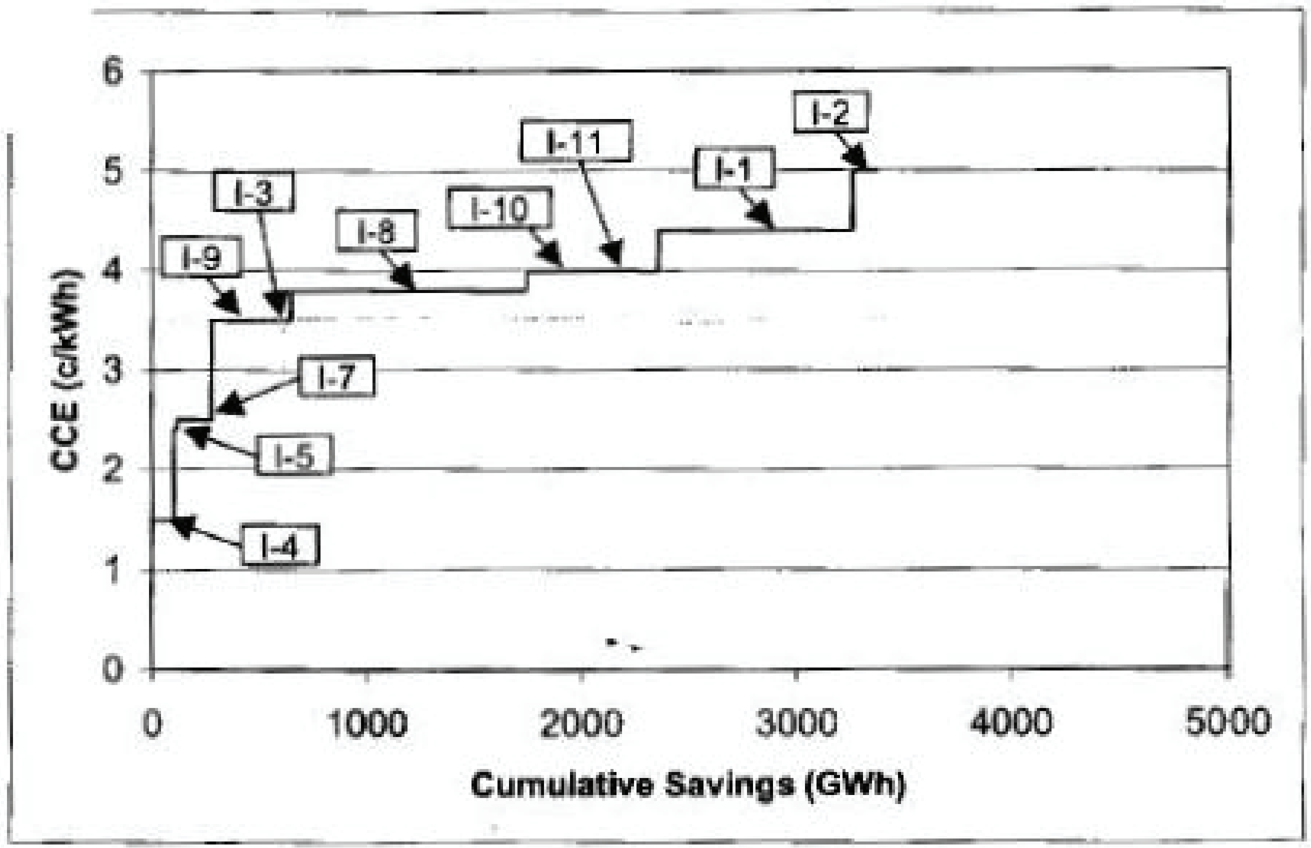
British Columbia



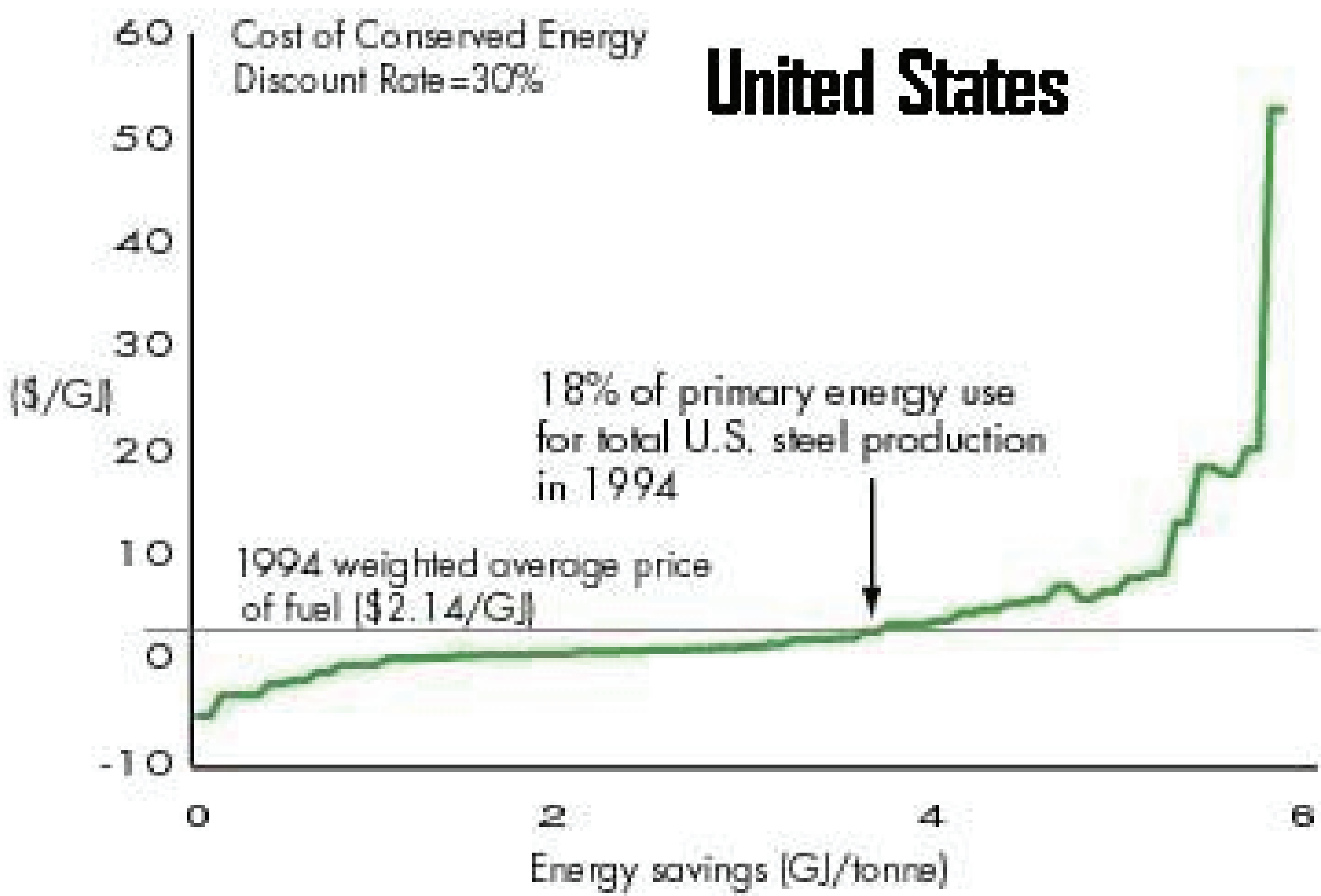
Marbek Resource Consultants and Willis Energy Services, 2003, British Columbia

Exhibit 6.12: Supply Curve of Industrial Sector Actions—Cumulative Electricity Savings in the Milestone Year of 2015/16 for Most Likely Scenario, (GWh/yr.)

British Columbia

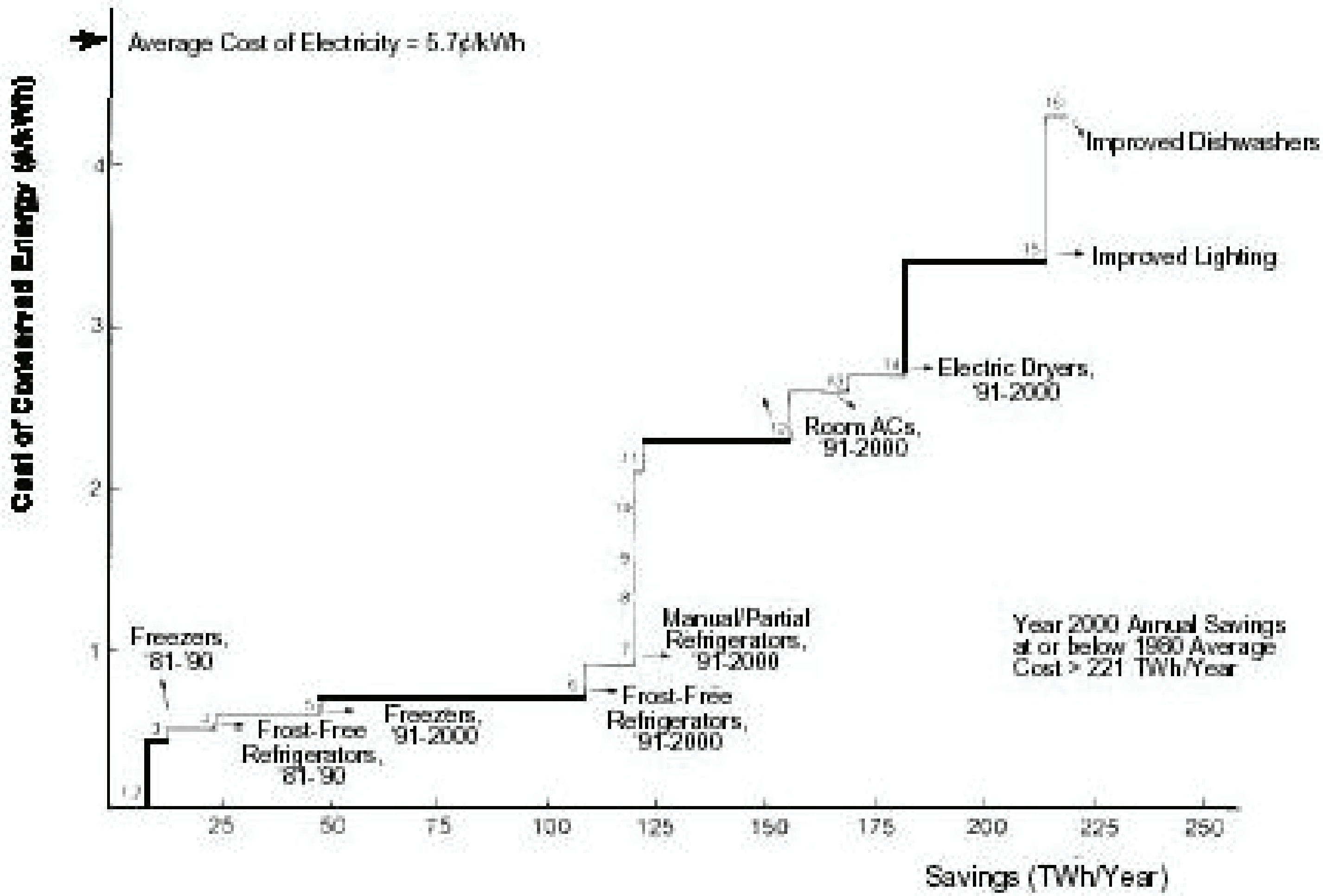


LBL, 1999, US



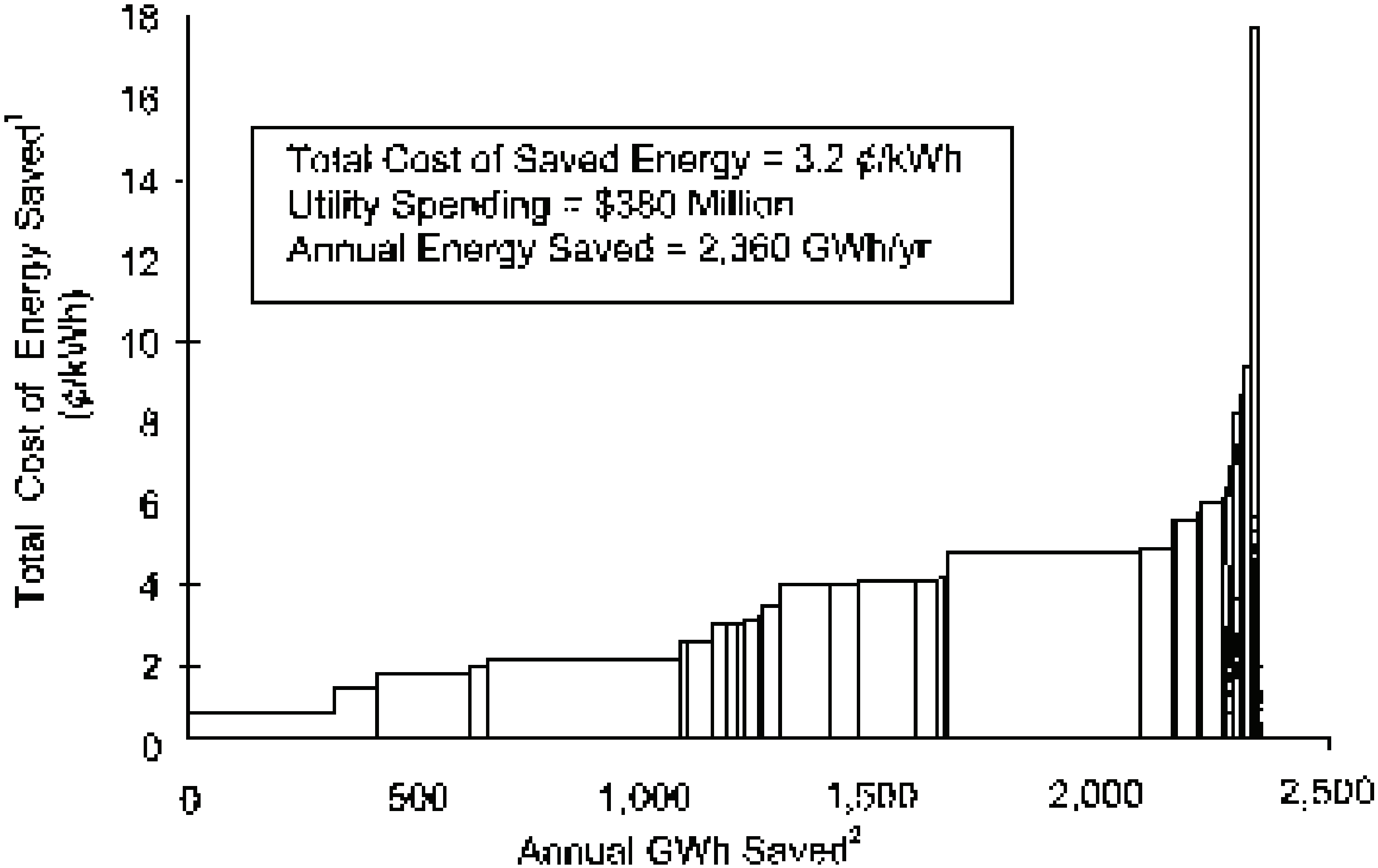
Cost of Conserved Energy
Discount Rate=30%
United States
60
50
40
30
($/GJ)
20
10
0
-10
18% of primary energy use
for total U.S. steel production
in 1994
1994 weighted average price
of fuel ($2.14/GJ)
0
2
4
6
Energy savings (GJ/tonne)

SERI, 1981, US



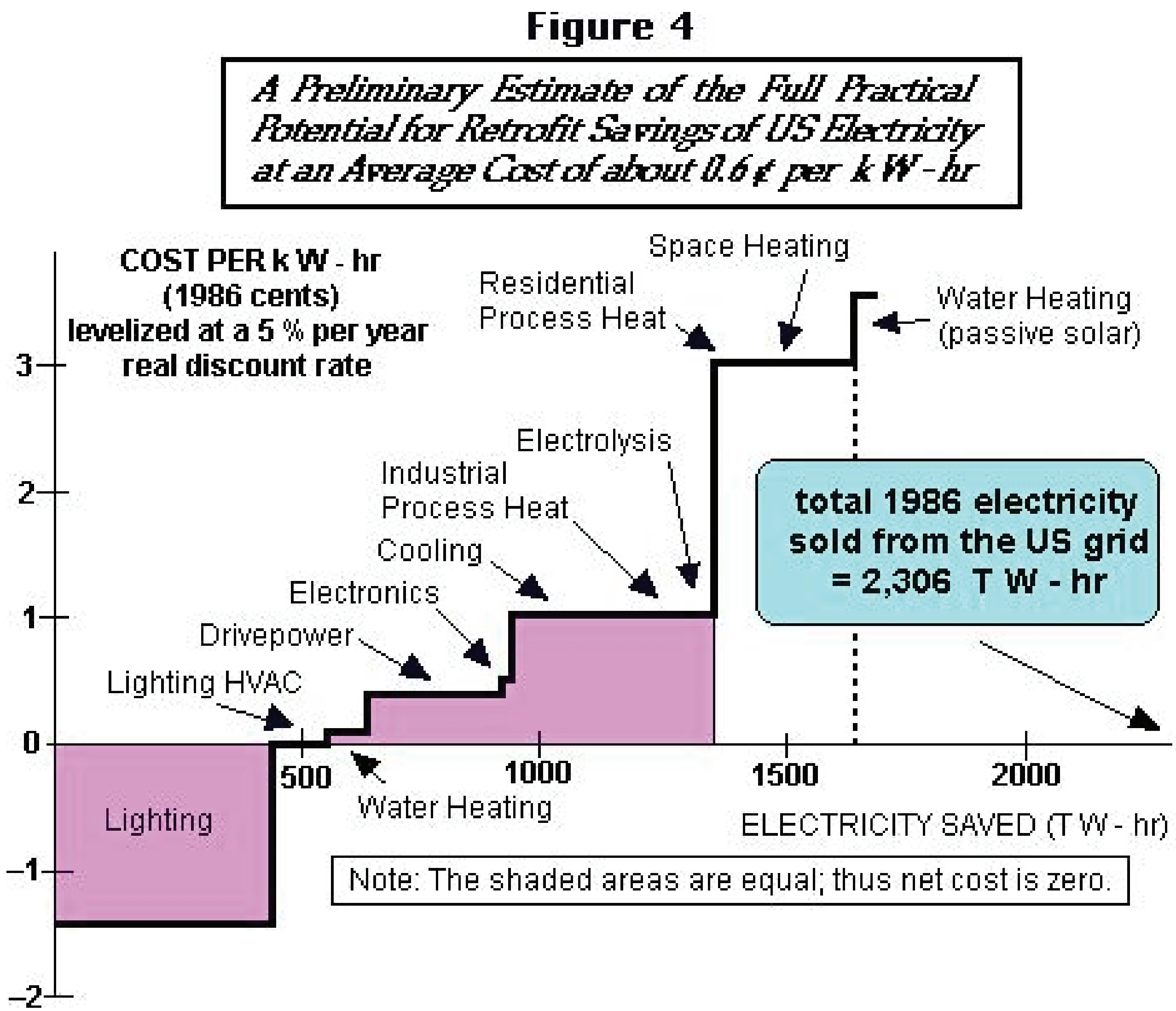
Average Cost of Electricity = 5.7¢/kWh
Cost of Conserved Energy (¢/kWh)
4
3
2
1
25
50
75
100
125
150
175
200
225
250
Savings (TWh/Year)
Freezers, '81-'90
Frost-Free Refrigerators, '81-'90
Freezers, '91-2000
Frost-Free Refrigerators, '91-2000
Manual/Partial Refrigerators, '91-2000
Room ACs, '91-2000
Electric Dryers, '91-2000
Improved Lighting
Improved Dishwashers
Year 2000 Annual Savings at or below 1980 Average Cost > 221 TWh/Year

LBL, 1995, US

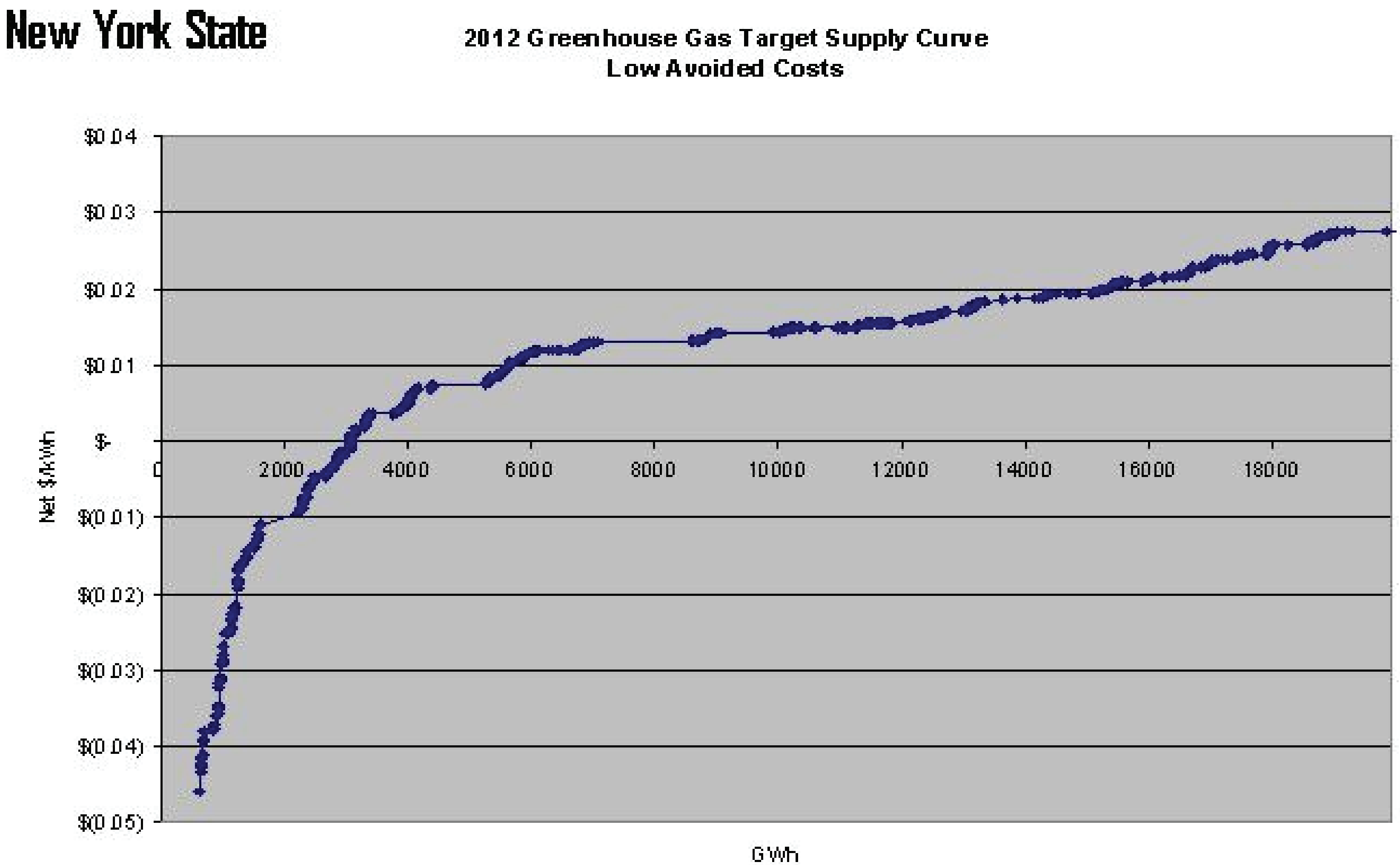


Source: Eto et al. 1995

Amory Lovins, 1989, US

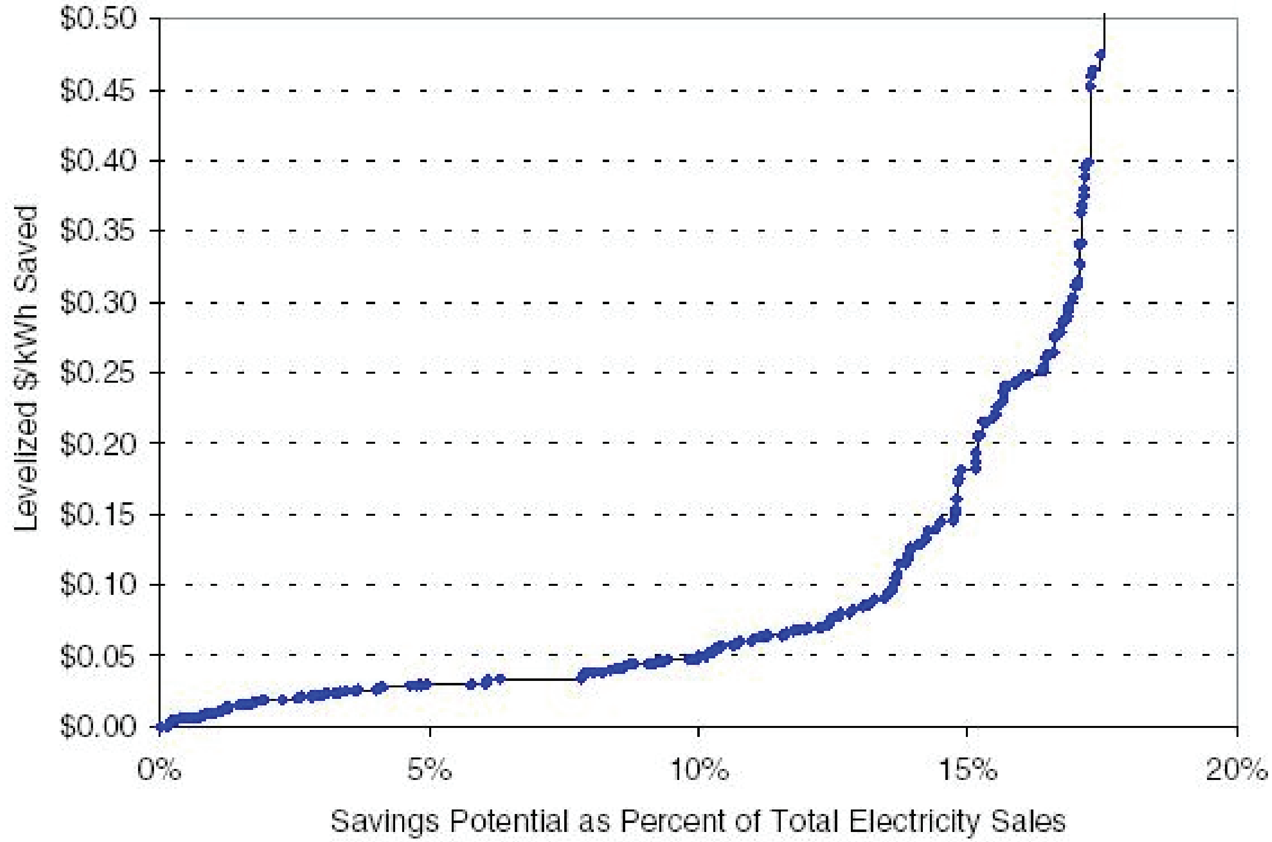


Optimal, 2003, New York State

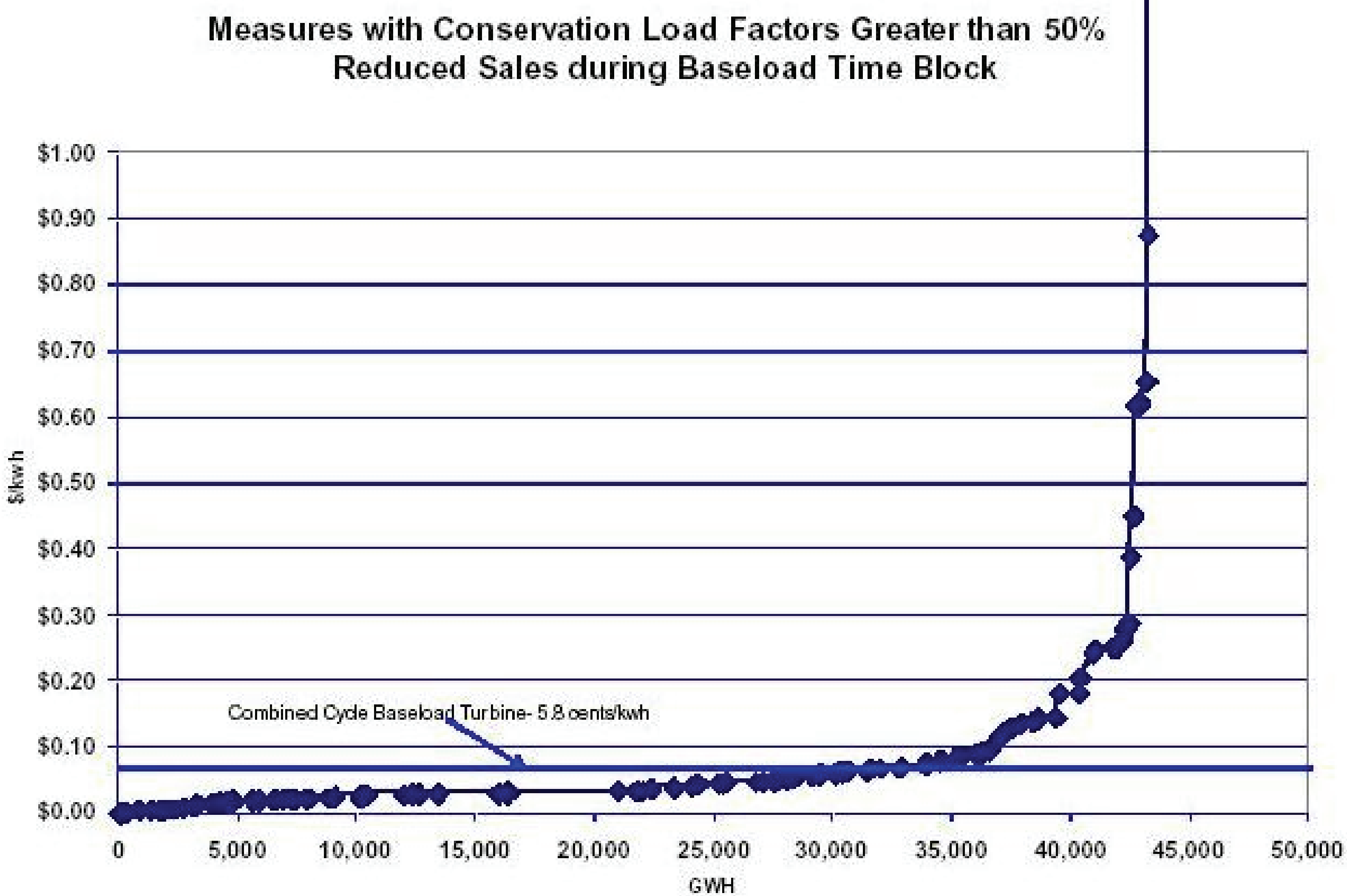


Xenergy, 2002, California

Figure 3-4
Energy-Efficiency Supply Curve—Potential in 2011*



Hewlett Energy Foundation, 2002, California



Northwest Power and Conservation Council, 2002, Pacific NW

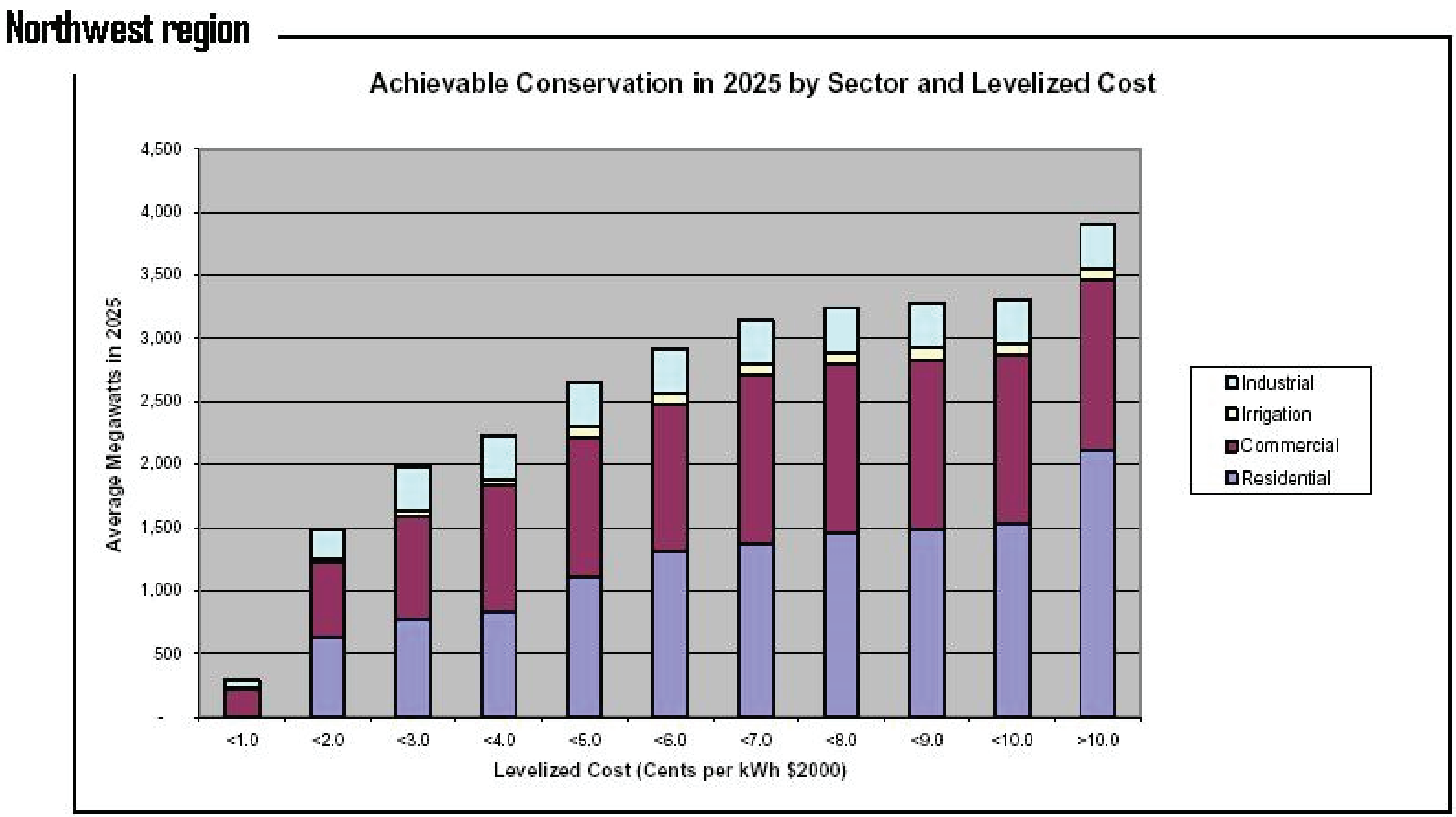
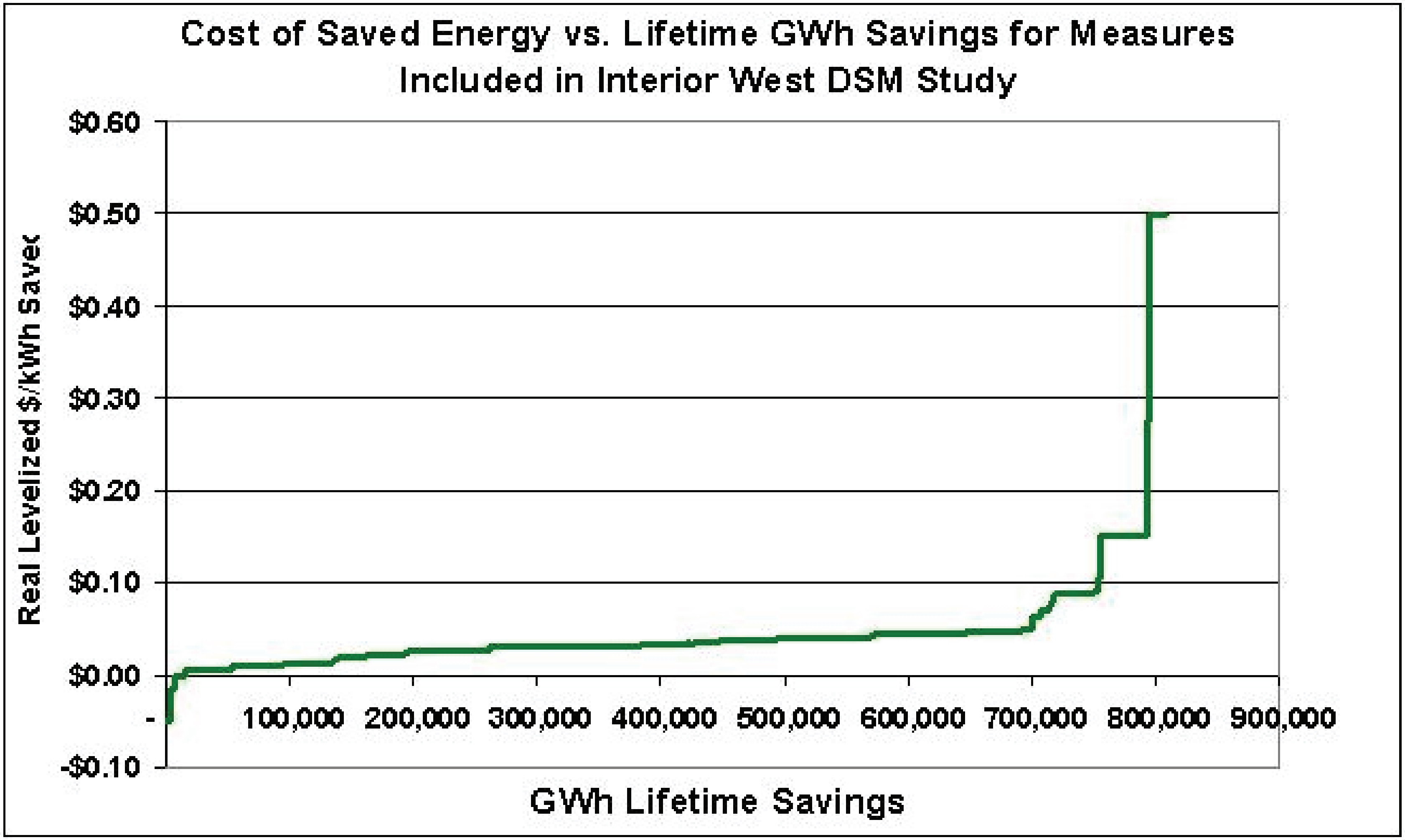
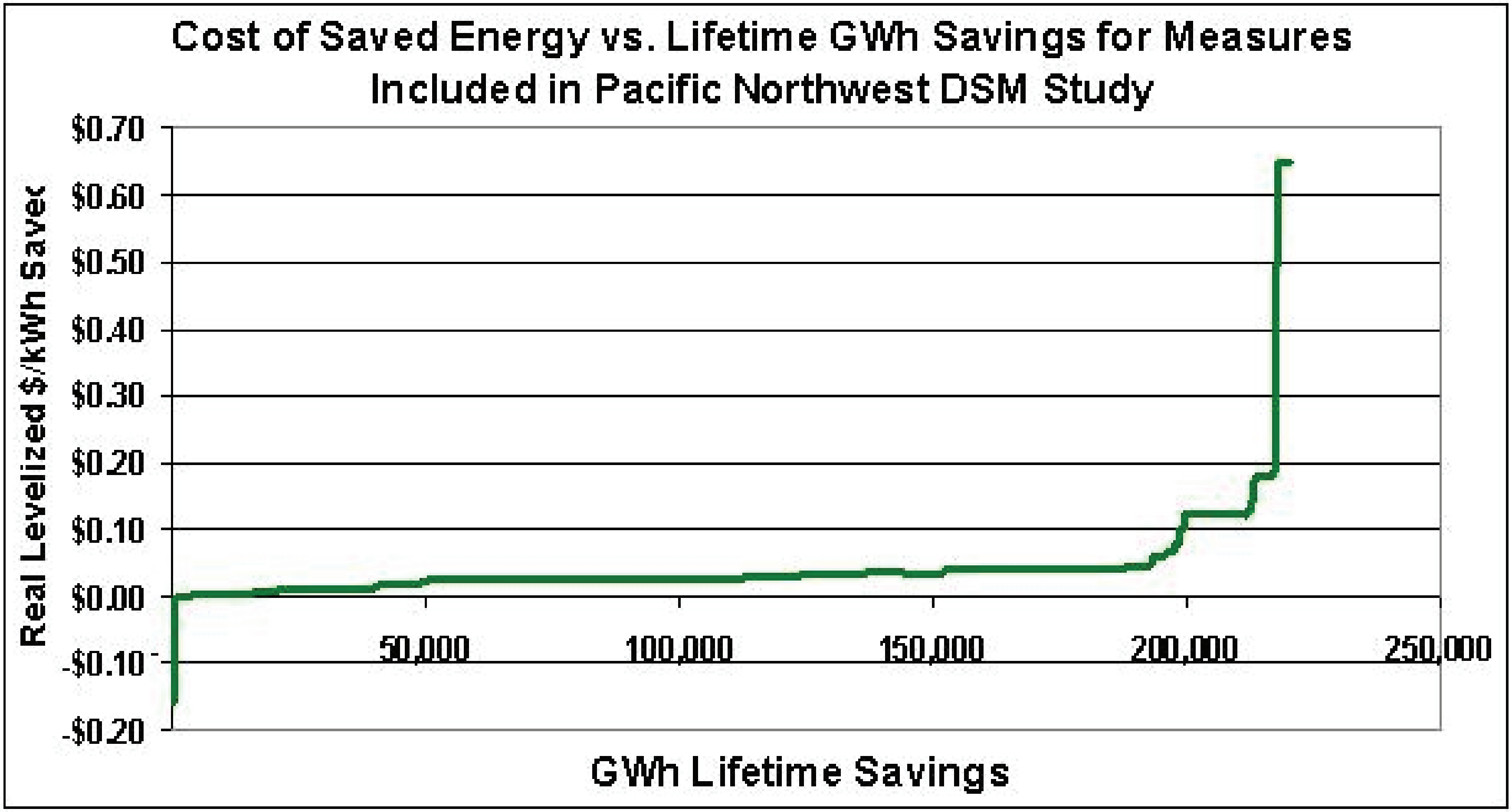


Figure 3-2: Achievable Conservation in 2025 by Sector and Levelized Cost

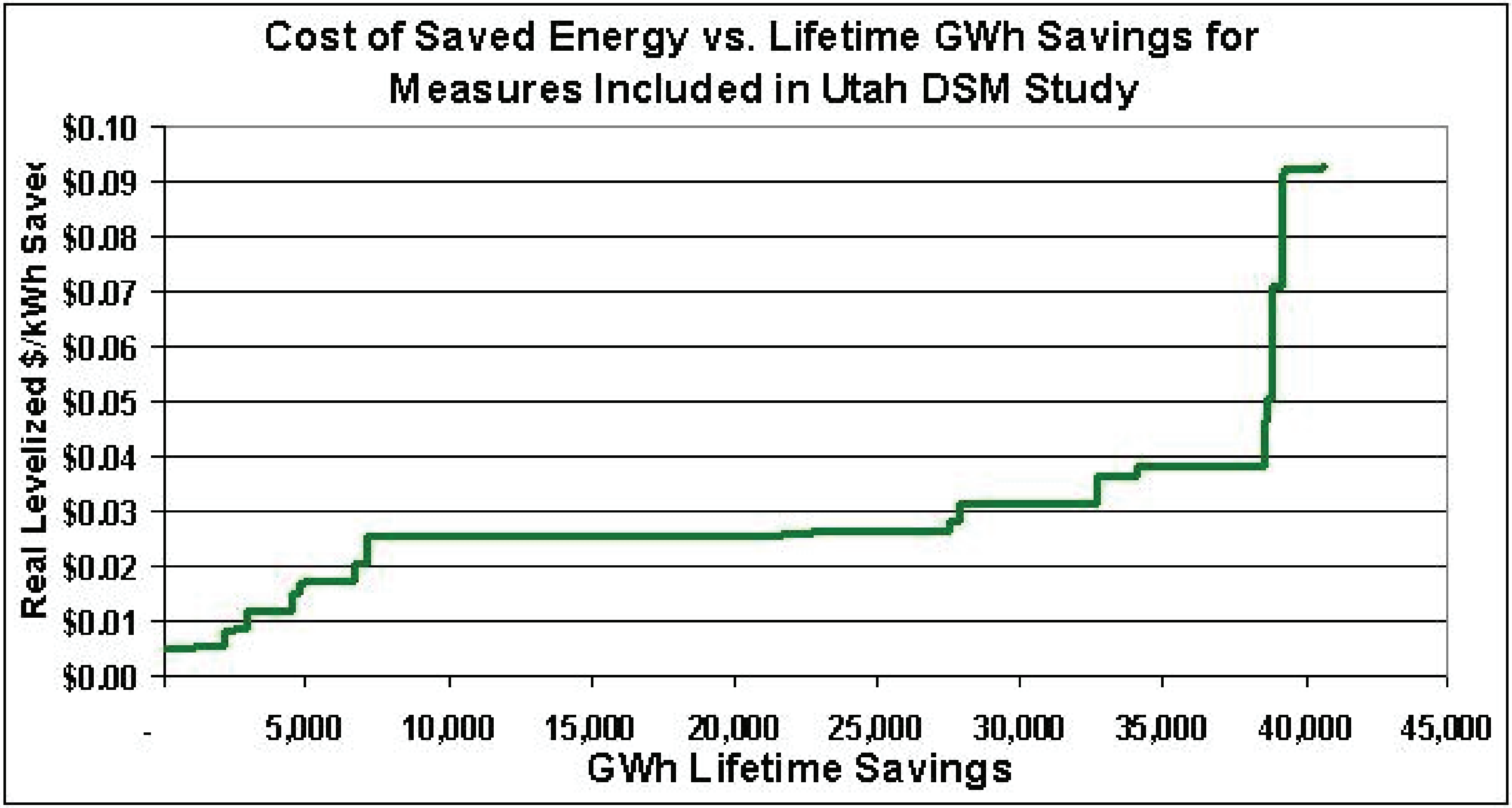
Tellus, 2001, Interior West



Tellus, 2001, Pacific NW

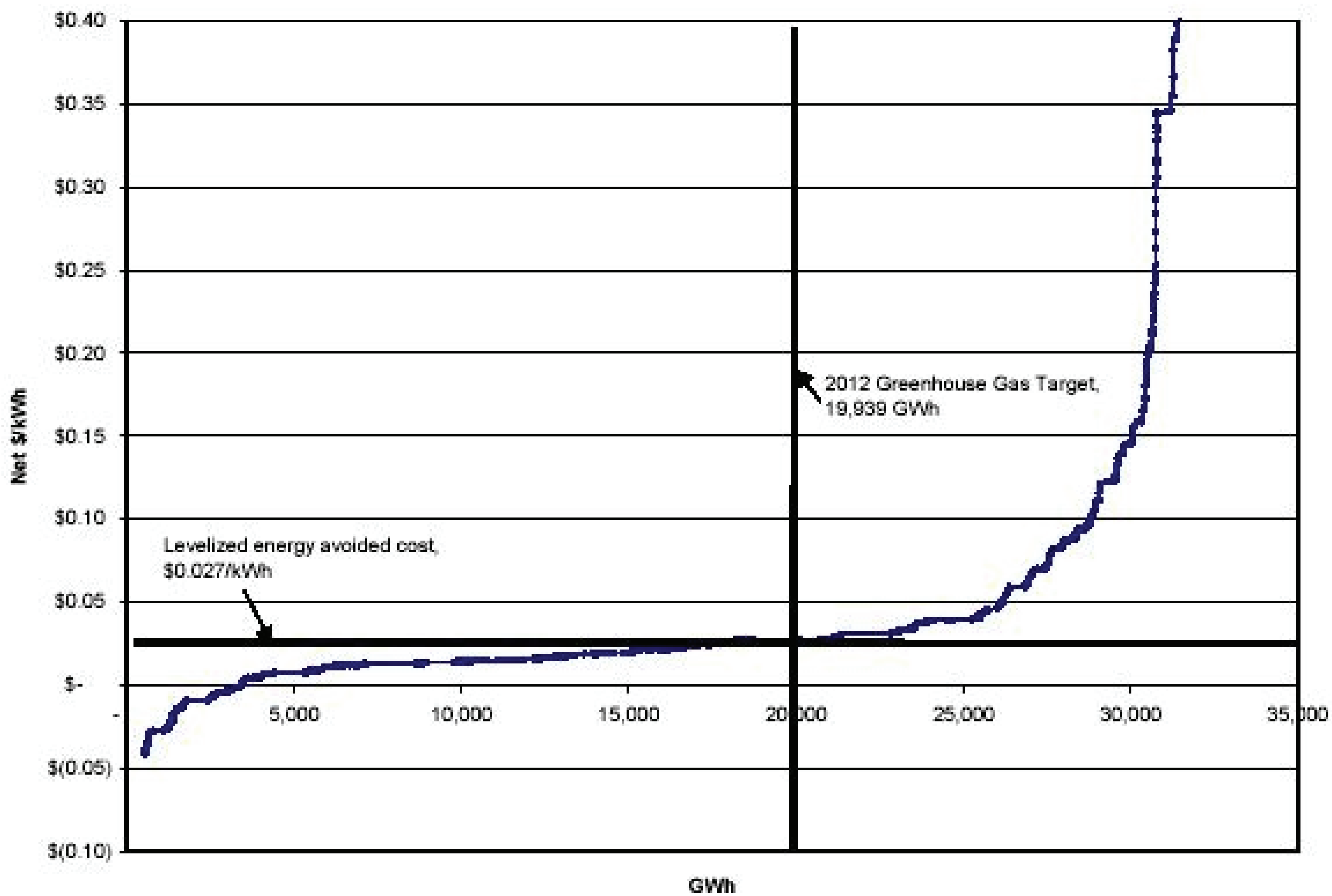


Tellus, 2001, Utah



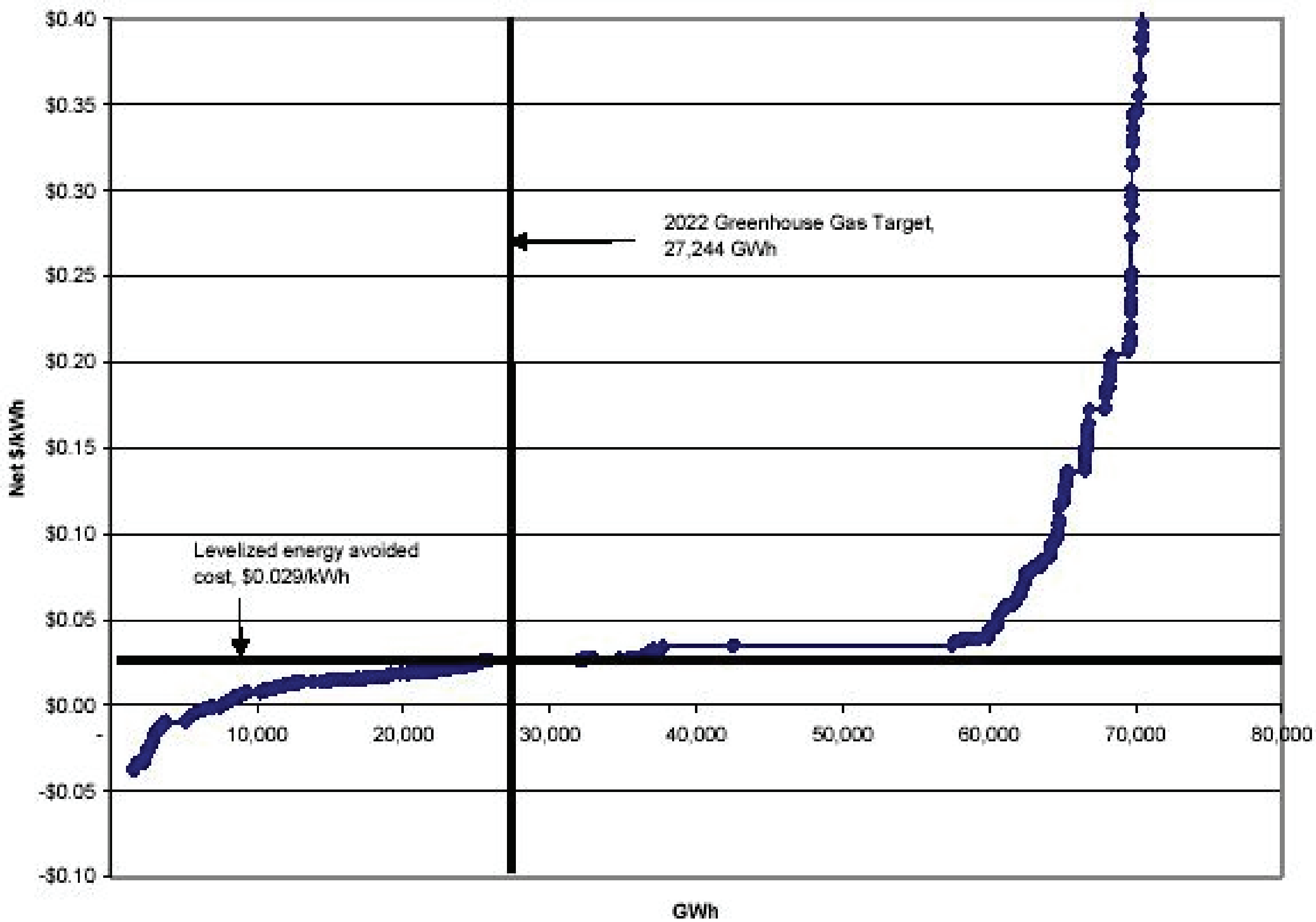
NYSERDA, 2003, New York State

Figure 1.10 Greenhouse Gas Target Supply Curve (2012, Low Avoided Costs)

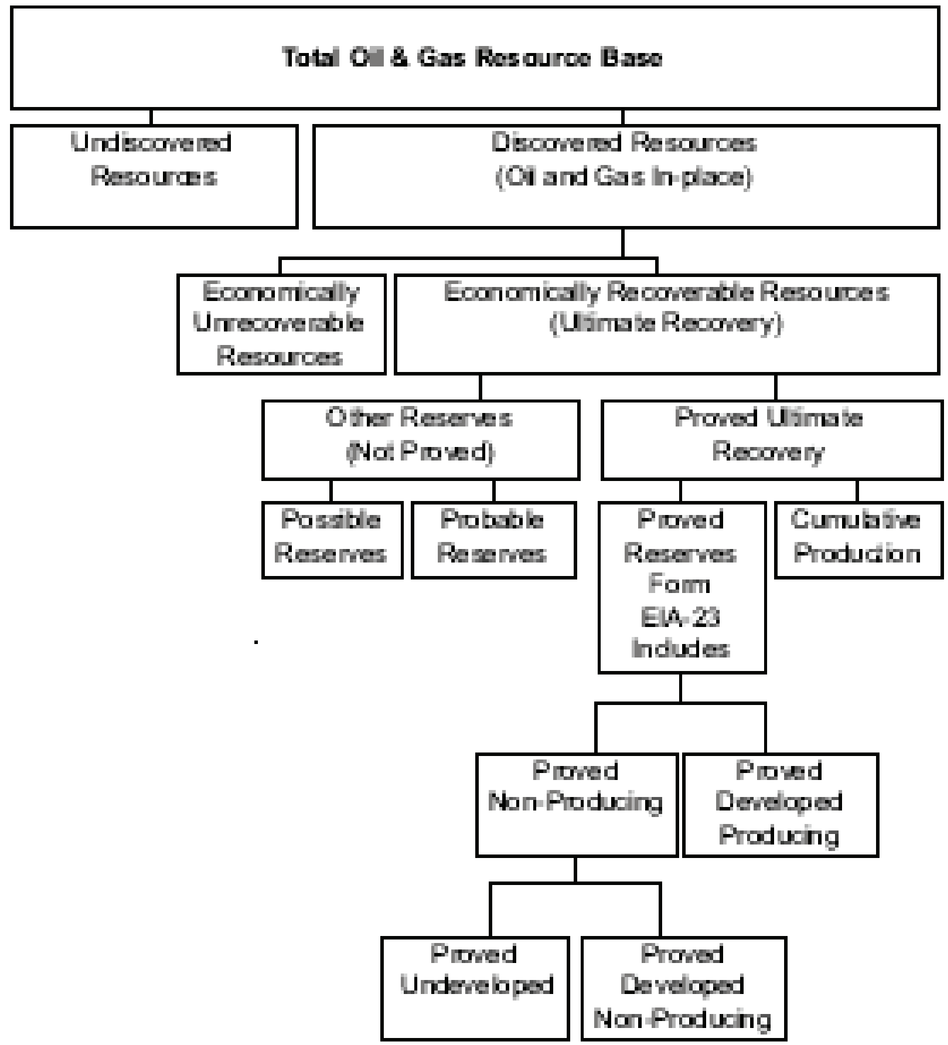


NYSERDA, 2003, New York State

Figure 1.11 Greenhouse Gas Target Supply Curve (2022 Low Avoided Costs)



EIA



Source: Energy Information Administration, Office of Oil and Gas.

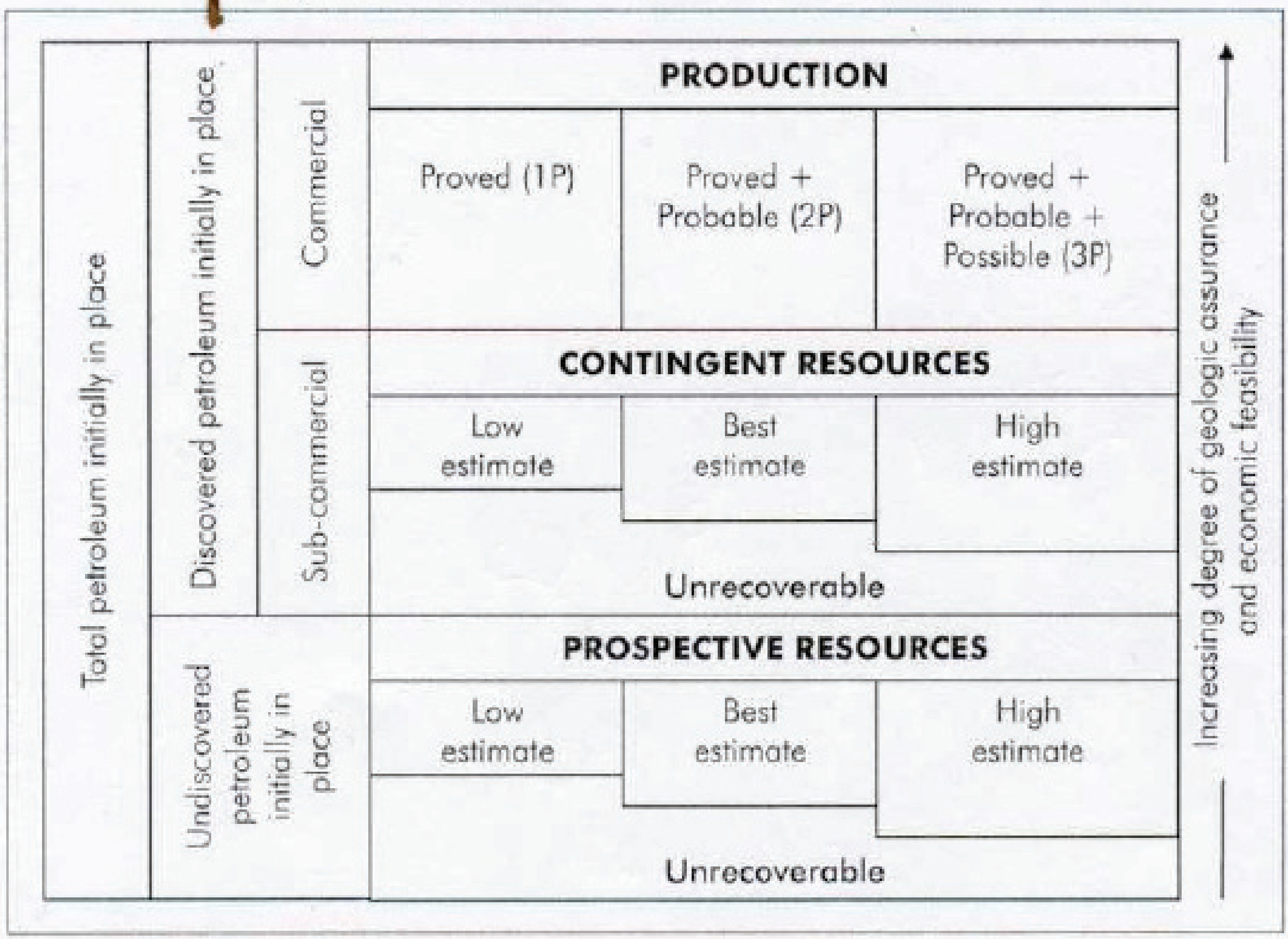
EIA

Table G2. Reserve Estimation Techniques

Method	Comments
Volumetric	Applies to crude oil and natural gas reservoirs. Based on raw engineering and geologic data.
Material Balance	Applies to crude oil and natural gas reservoirs. Is used in estimating reserves. Usually of more value in predicting reserves, and reservoir performance.
Pressure Decline	Applies to nonassociated and associated gas reservoirs. The method is a special case of material balance equation in the absence of water influx.
Production Decline	Applies to crude oil and natural gas reservoirs during production decline (usually in the later stages of reservoir life).
Reservoir Simulation	Applies to crude oil and natural gas reservoirs. Is used in estimating reserves. Usually of more value in predicting reservoir performance. Accuracy increases when matched with past pressure and production data.
Nominal	Applied to crude oil and natural gas reservoirs. Based on rule of thumb or analogy with another reservoir or reservoirs believed to be similar; least accurate of methods used.

Hydrocarbon Resource Classification

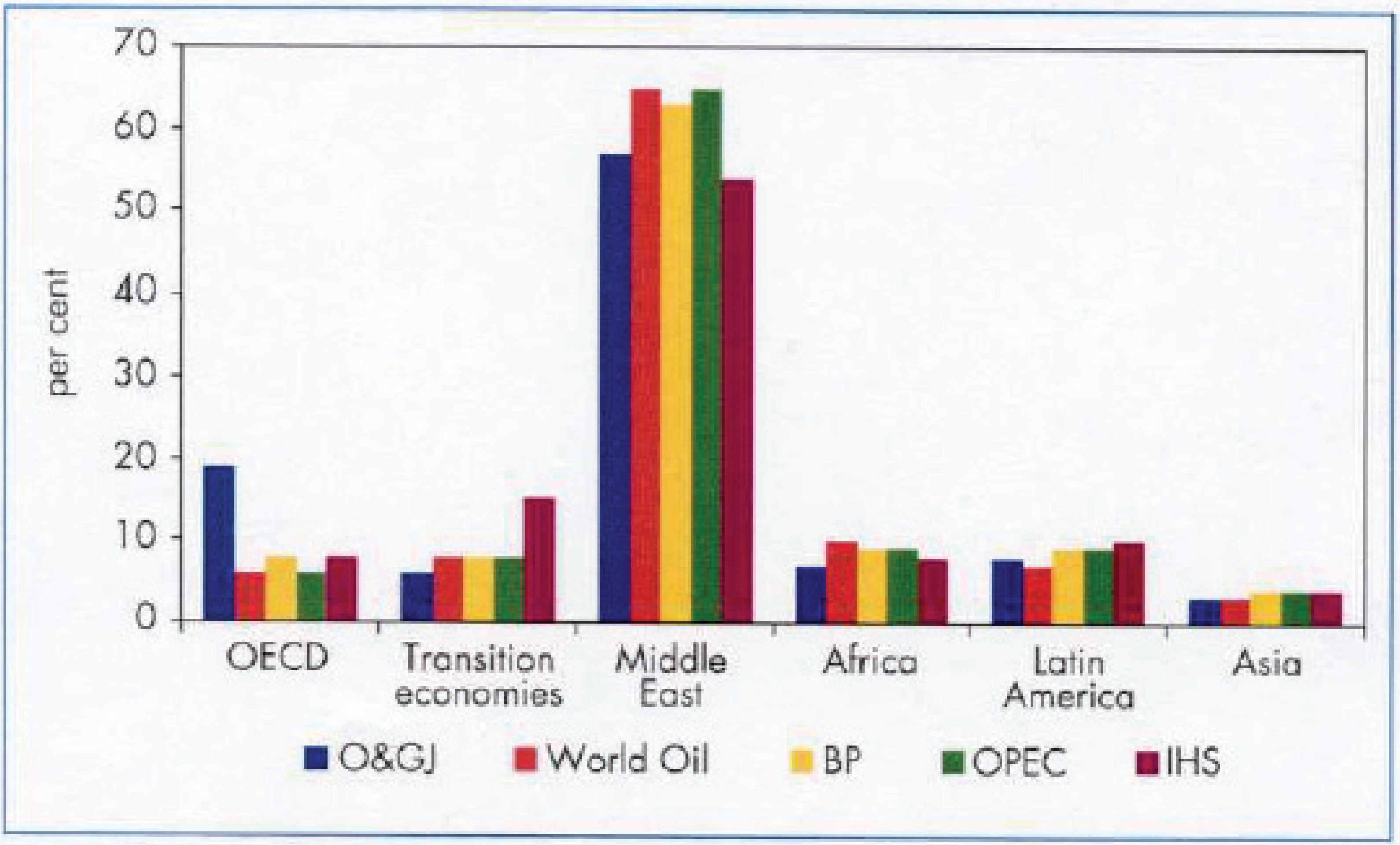
Figure 3.7: **Hydrocarbon-Resource Classification**



Source: SPE/WPC/AAPG (2000).

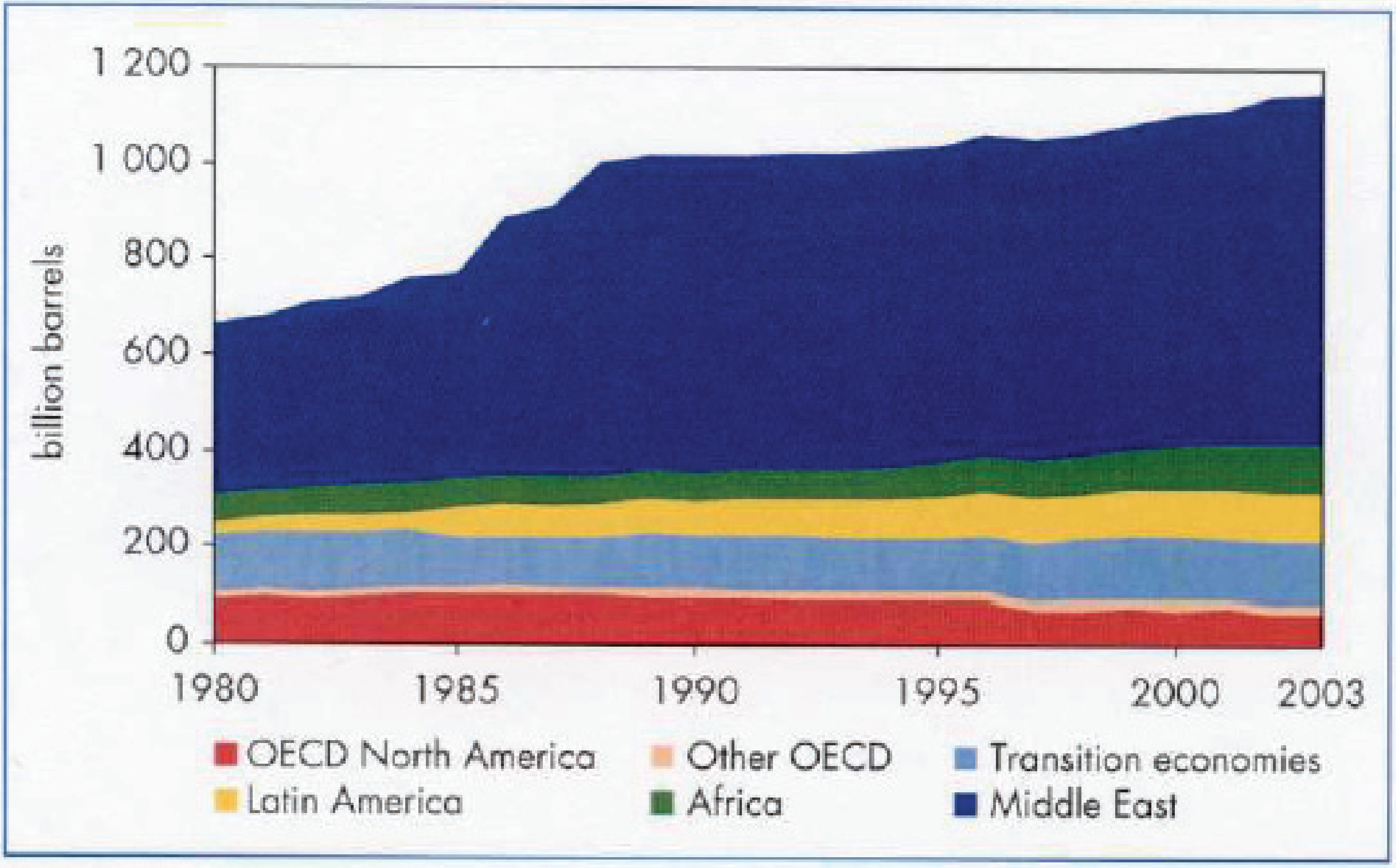
IEA Regional Shares

Figure 3.9: **Regional Share of Proven Oil Reserves**



Proven Reserves by Region

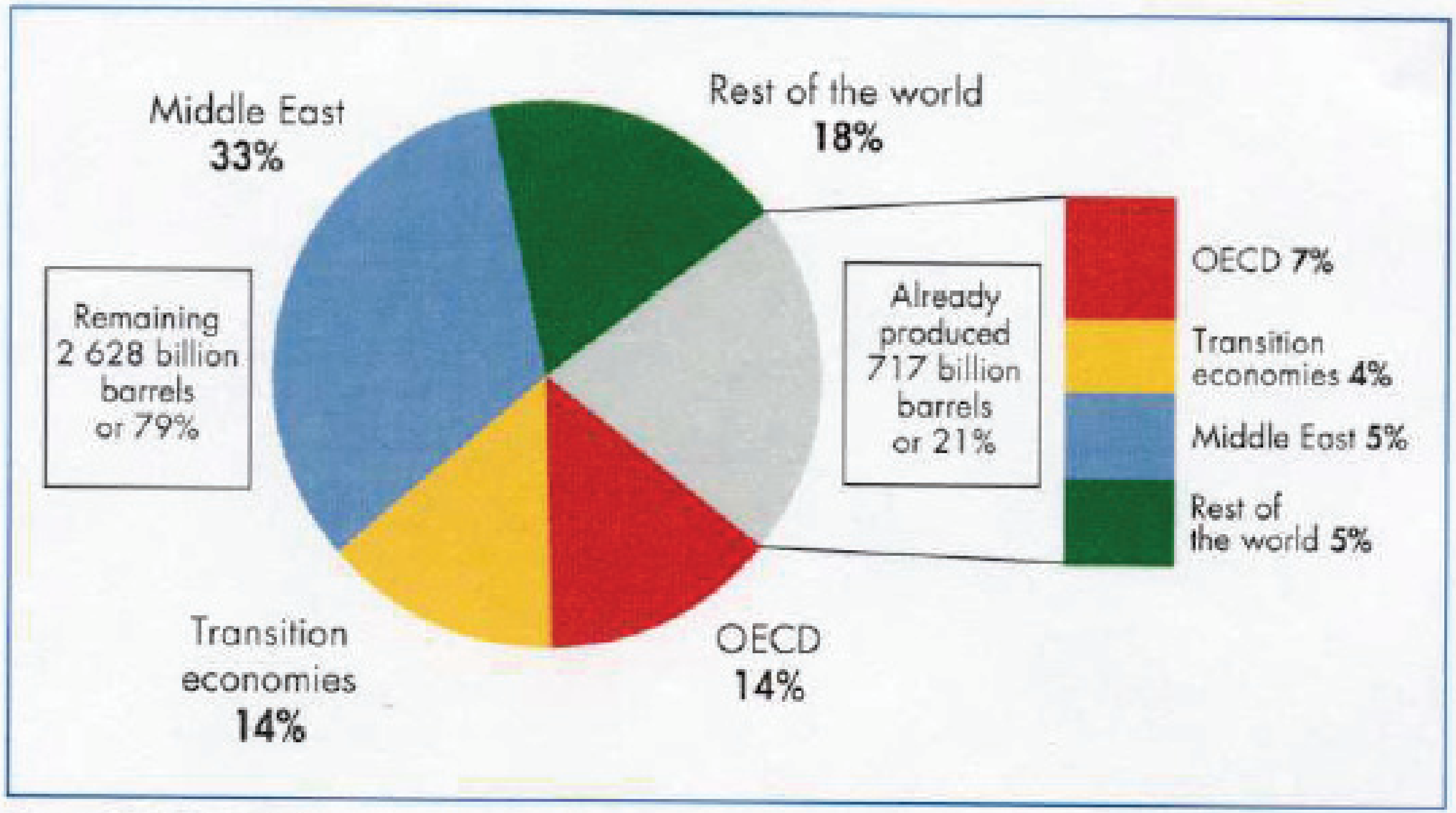
Figure 3.10: **Proven Oil Reserves by Region**



Source: BP (2004).

Ultimately Recoverable

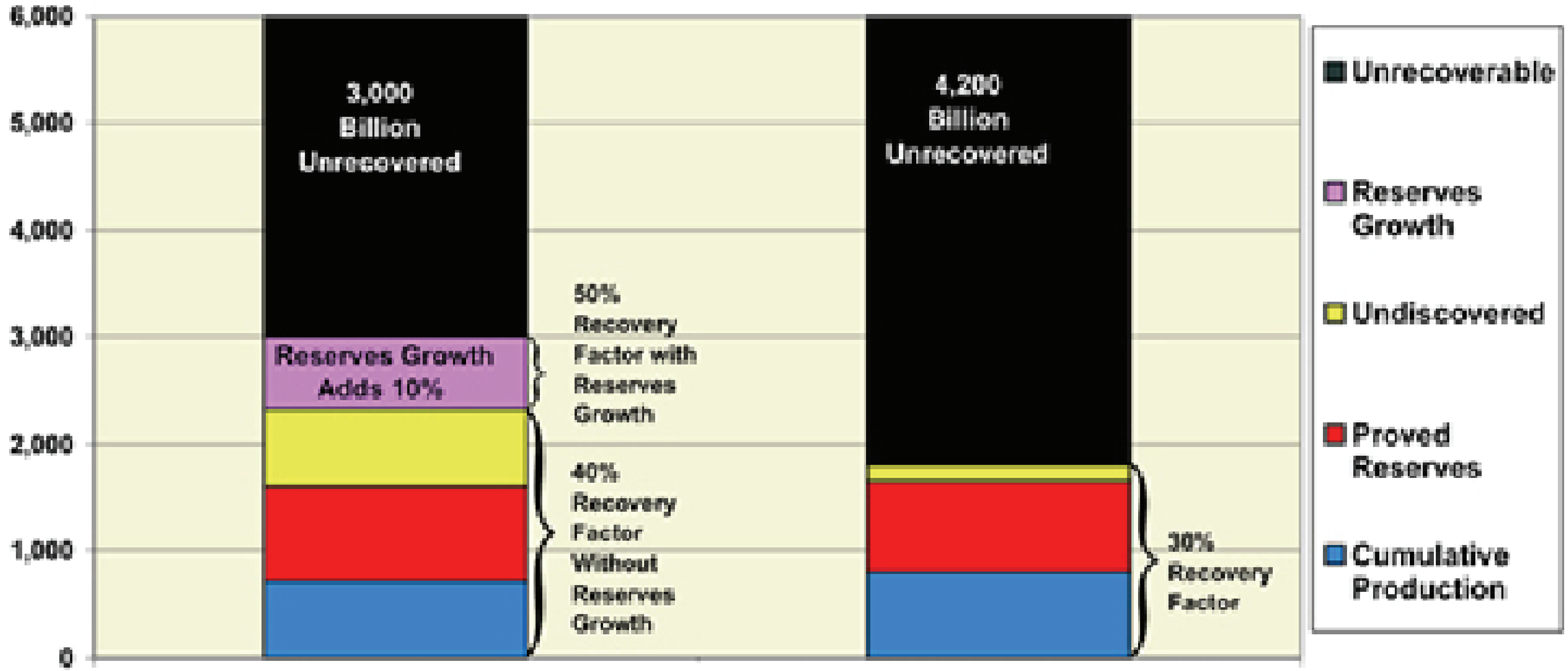
Figure 3.11: **Ultimately Recoverable Resources of Oil and NGL by Region**
(mean value)



Source: USGS (2000).

World Original Resource Base

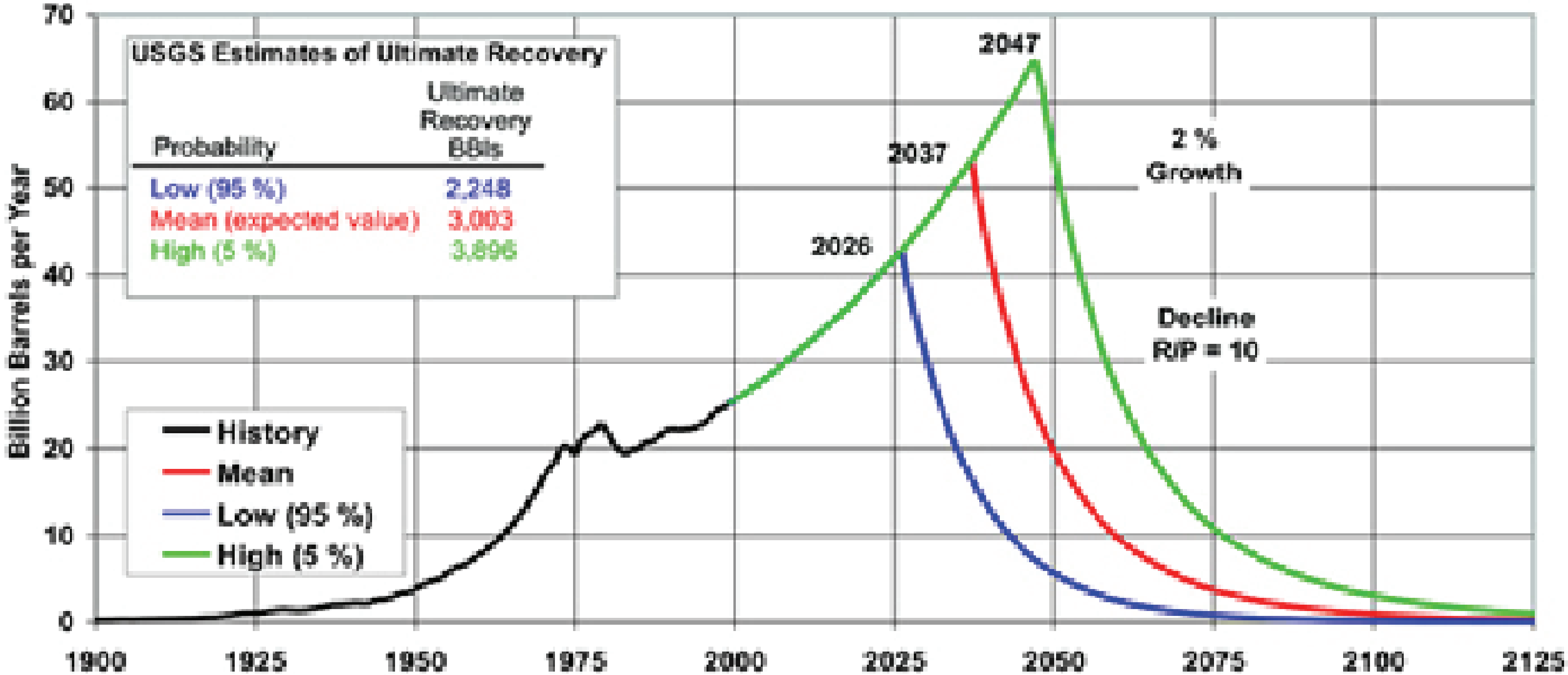
Figure 1. Different Interpretations of a Hypothetical 6,000 Billion Barrel World Original Oil-in-Place Resource Base



Source: Energy Information Administration

Annual Production Scenarios

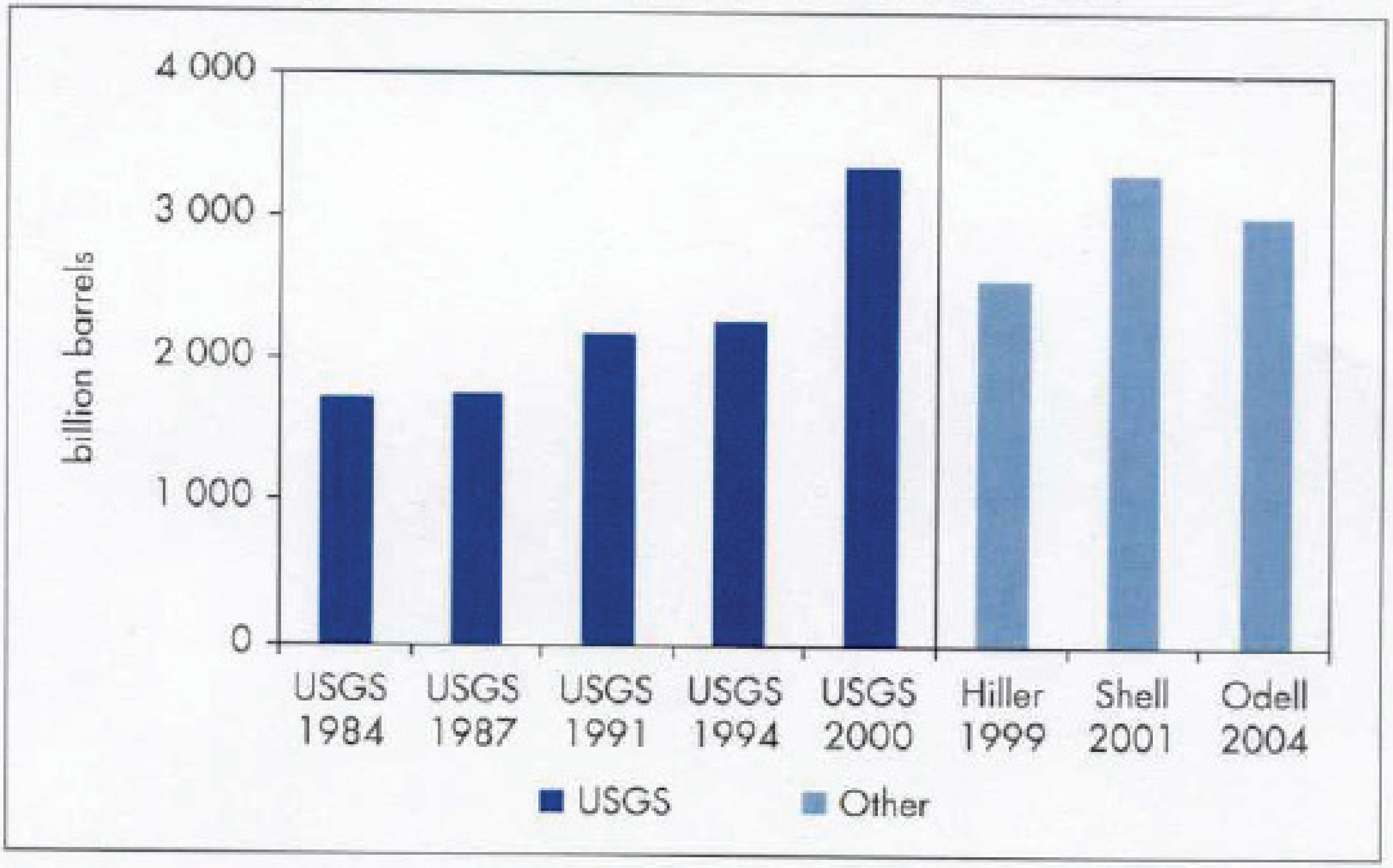
Figure 2. Annual Production Scenarios with 2 Percent Growth Rates and Different Resource Levels (Decline R/P=10)



Source: Energy Information Administration
Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.

Ultimately Recoverable Oil

Figure 3.12: **Ultimately Recoverable Oil Resources**



Research Ideas

- Analysis of CSE curves – past projections v. what actually happened
- Identify reasons for upturn in CSE price
- Characterize reasons and quantify to the extent possible – by technology.
- Apply concepts from oil and gas reserves?

Xenergy, Generic Curve