

Criteria and Indicators of Sustainable Development for Energy and Mineral Systems

Indicators are useful as analytical, explanatory, communication, planning, and performance assessment tools.

Indicators should be representative of the chosen system (economic, environmental, and social), have a scientific basis, be quantifiable, be without social bias, and represent manageable processes.

Effective indicators turn vast amounts of analyzed data into meaningful and relevant information and, in so doing, reduce complexity and bring clarity.

The primary purpose of the set of indicators is to:

- Encourage a national dialogue.
- Identify types of information needed.
- Highlight strategic trends and priorities.
- Support an interim assessment of the progress toward sustainability goals as they relate to nonrenewable resources.

The indicators chosen by the Sustainable Minerals Roundtable describe a broad range of attributes of energy and mineral systems.

Indicators were:

- **Developed through the course of 18 meetings.**
 - **Considered from previous work.**
 - **Proposed by attendees.**
 - **Discussed and debated for meaning and usefulness to sustainability issues.**
 - **Reviewed and refined by the full Roundtable.**
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Indicators were organized under the following four criteria:

- Maintenance of capacities to produce commodities (28 indicators).
- Maintenance of environmental quality (8 indicators).
- Maintenance of long-term economic, cultural, and social benefits (31 indicators).
- Legal, institutional, and economic framework (15 indicators).

Indicators were prioritized based on:

- **Relevance to sustainability.**
- **Scale to which they apply.**
- **Whether the science exists.**
- **Level of interest.**
- **Whether the data exist.**
- **Complexity, time, and resources necessary to populate the indicator.**

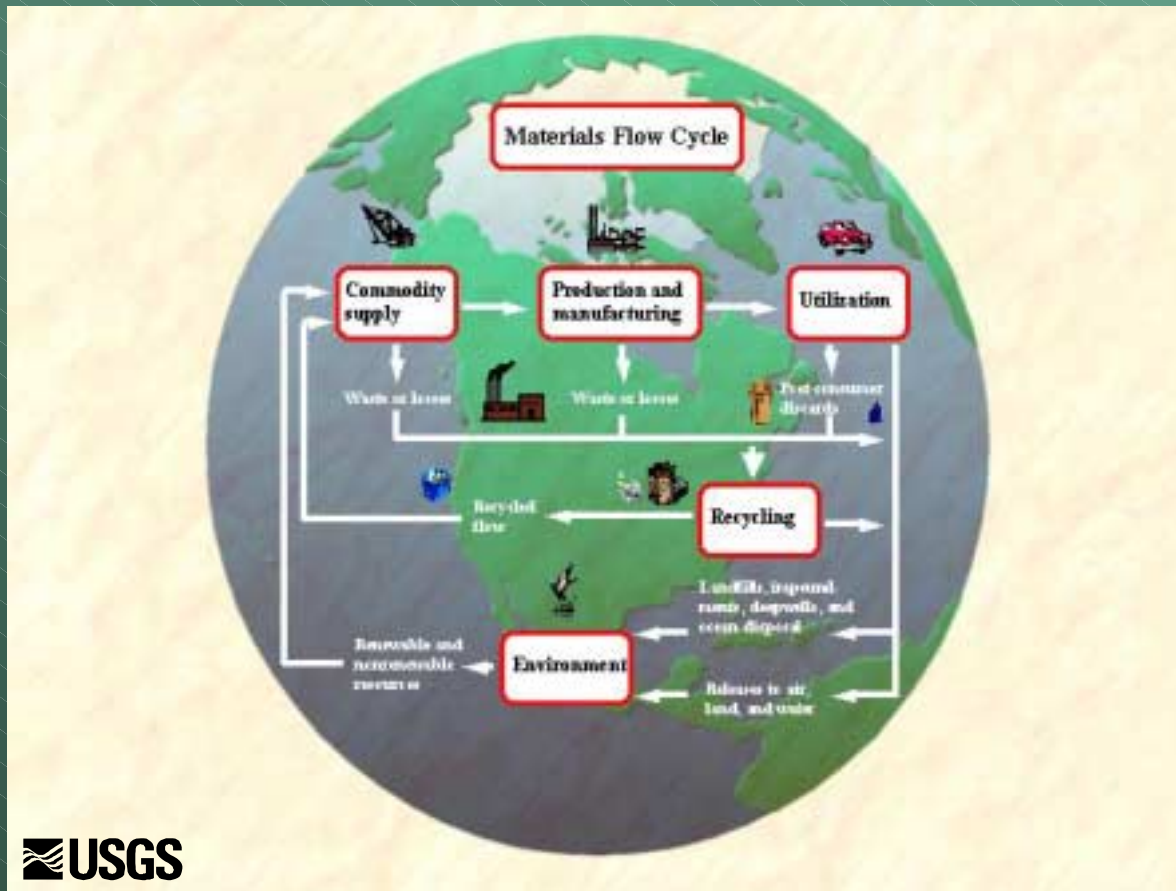
Number of priority indicators for each criterion:

- **Maintenance of capacities to produce commodities (13 indicators).**
- **Maintenance of environmental quality (7 indicators).**
- **Maintenance of long-term economic, cultural, and social benefits (10 indicators).**
- **Legal, institutional, and economic framework (8 indicators).**

Productive Capacity Criterion

The goal of this criterion is to assess the Nation's energy and mineral resources and the capability to meet the needs of current and later generations.

Productive Capacity Criterion



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Productive Capacity Sub-Criteria

- **Resources.**
- **Exploration capacity.**
- **Production (extractive) capacity.**
- **Processing capacity (smelting, refining, and transportation).**
- **Use of energy and minerals.**

Productive Capacity Criterion Resources Sub-Criterion

Priority Indicator:

- Lands available for access for exploration, development, or protection.
- Average grade of ores produced.
- Identified resources.

Productive Capacity Criterion

Exploration Capacity Sub-Criterion

Priority Indicators:

- Exploration activity over time:
 - Annual drilling length.
 - Annual amount budgeted for exploration.
 - Discovery rate/dollar or level of effort expended.
 - Annual exploration rig utilization.
 - Annual domestic coal leases and licenses.

Productive Capacity Criterion

Production Capacity Sub-Criterion

Priority Indicators:

- National supply mix of mineral commodities and energy:
 - Domestic production
 - Imports
 - Exports
 - Net import reliance

Productive Capacity Criterion

Processing Capacity Sub-Criterion

Priority Indicators:

- Virgin/recycled materials.
- Capacity of oil and gas pipelines and electrical transmission lines.

Productive Capacity Criterion

Use of Minerals and Energy Sub-Criterion

Priority Indicators:

- Consumption or use of mineral commodities and energy over time.
- Stocks in use.

Status of Productive Capacity Criterion Indicators

- Drafts currently available: access to Federal lands; exploration; consumption of energy and mineral commodities; national supply mix; and stocks in use.
- The following indicators are in process: lands available for access and protection; and ratio of virgin to recycled minerals.
- All others are yet to be started.

Environmental Quality Criterion

This criterion covers the influences of the energy and mining sectors on the environment, including air, surface water, groundwater, and land. Includes extraction, processing, and transportation to the smelter/refinery.

Environmental Quality Sub-Criteria

- **Ambient environment.**
- **Management of extraction and processing.**
- **Reclamation/remediation/restoration of extraction sites.**
- **Environmental releases.**

Environmental Quality Criterion Ambient Environment Sub-Criterion

Priority Indicators:

- **Compliance with respect to water quality.**
- **Water withdrawals.**
- **Groundwater contamination.**

Environmental Quality Criterion Management of Extraction and Processing Sub-Criterion

Priority Indicator:

- **Water use efficiency.**

Environmental Quality Criterion

R/R/R of Sites Sub-Criterion

Priority Indicators:

- Area reclaimed / remediated / restored relative to area scheduled for same.
- Rate of abandoned mine creation / rate of reclamation / remediation / restoration.

Environmental Quality Criterion Releases to the Environment Sub- Criterion

Priority Indicator:

- Quantity of release to environment/quantity of output.

Status of Environmental Quality Criterion Indicators

- **Some data collection has started.**

Socio-Economic Benefits Criterion

The objective of this criterion is to provide information that can be used to assess the socio-economic impacts associated with energy and mineral activities in the United States.

Socio-Economic Benefits Sub-Criteria

- **Local.**
- **National.**
- **Recreation and tourism.**
- **Cultural, social, and spiritual needs.**
- **Equity.**

Socio-Economic Benefits Criterion

Local Sub-Criterion

Priority Indicators:

- Employment and income in the energy and minerals sectors
- Other income to communities (royalties, severance taxes, property taxes, and other contributions).

Socio-Economic Benefits Criterion

National Sub-Criterion

Priority Indicators:

- Output/labor expenditure.
- Value of production.
- Net trade balance.
- Total net income.
- National employment and income.
- Total investment.

Socio-Economic Benefits Criterion Cultural, Social, and Spiritual Needs Sub-Criterion

Priority Indicator:

- **Social characteristics of nonrenewable resource-dependent counties.**

Socio-Economic Benefits Criterion

Equity Sub-Criterion

Priority Indicator:

- Poverty levels in nonrenewable resource-dependent counties.

Status of Socio-Economic Benefits Criterion Indicators

- Drafts available for output/labor expenditure in the mining sector, total investment by the mining sector, and the value of energy and mineral production.
- Work has begun on additional indicators.

Legal and Institutional Criterion

The purpose of this criterion is to describe the overall policy framework within which energy and minerals activities take place.

Legal and Institutional Sub-Criteria

- **Legal framework.**
- **Institutional framework.**
- **Economic framework.**

Legal and Institutional Criterion

Legal Framework Sub-Criterion

Priority Indicators:

- Property rights, traditional rights, and dispute resolution.
- Resource assessment, land-use planning, and policy review.
- Compliance and enforcement framework, and decision processes.
- Reuse, recycling, and remanufacture.

Legal and Institutional Criterion

Institutional Framework Sub-Criterion

Priority Indicators:

- **Public involvement activities.**
- **Skilled workforce.**

Legal and Institutional Criterion

Economic Framework Sub-Criterion

Priority Indicators:

- Investment and taxation policies that enhance or inhibit sustainable practices.
- Identification and reporting of external costs.

Status of Legal and Institutional Criterion Indicators

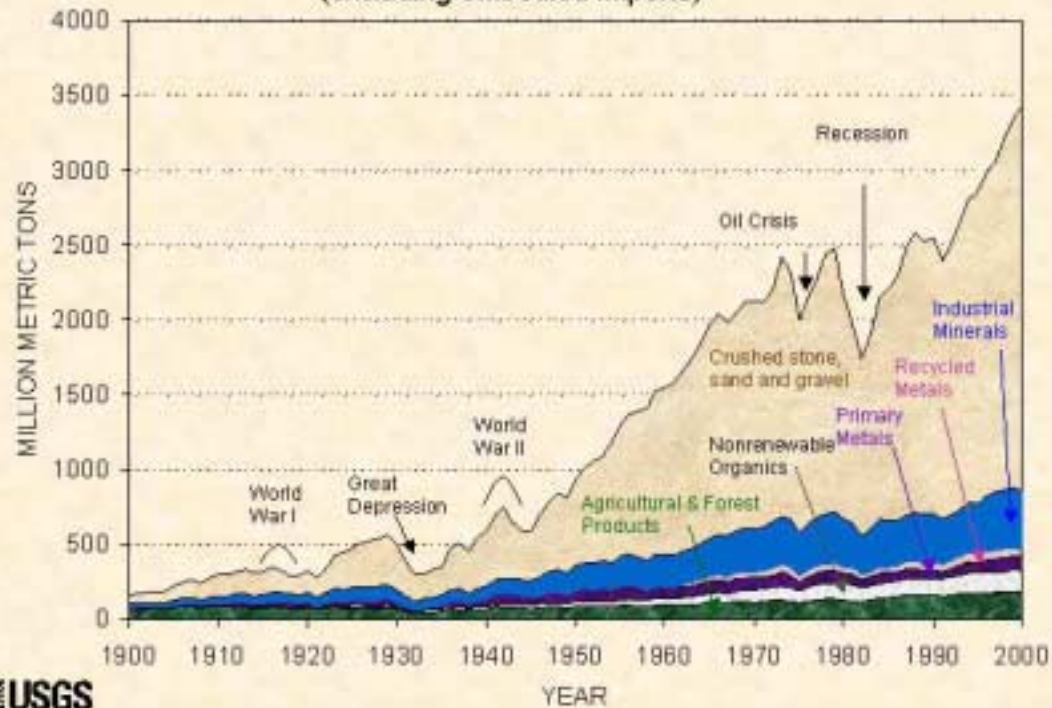
- **Work has begun to develop the indicators.**

Example Indicators

- **Productive Capacity Criterion — Consumption (use) of energy and mineral commodities over time.**
- **Productive Capacity Criterion — Exploration activity over time.**

Example Indicator — Consumption (use) of Mineral Commodities

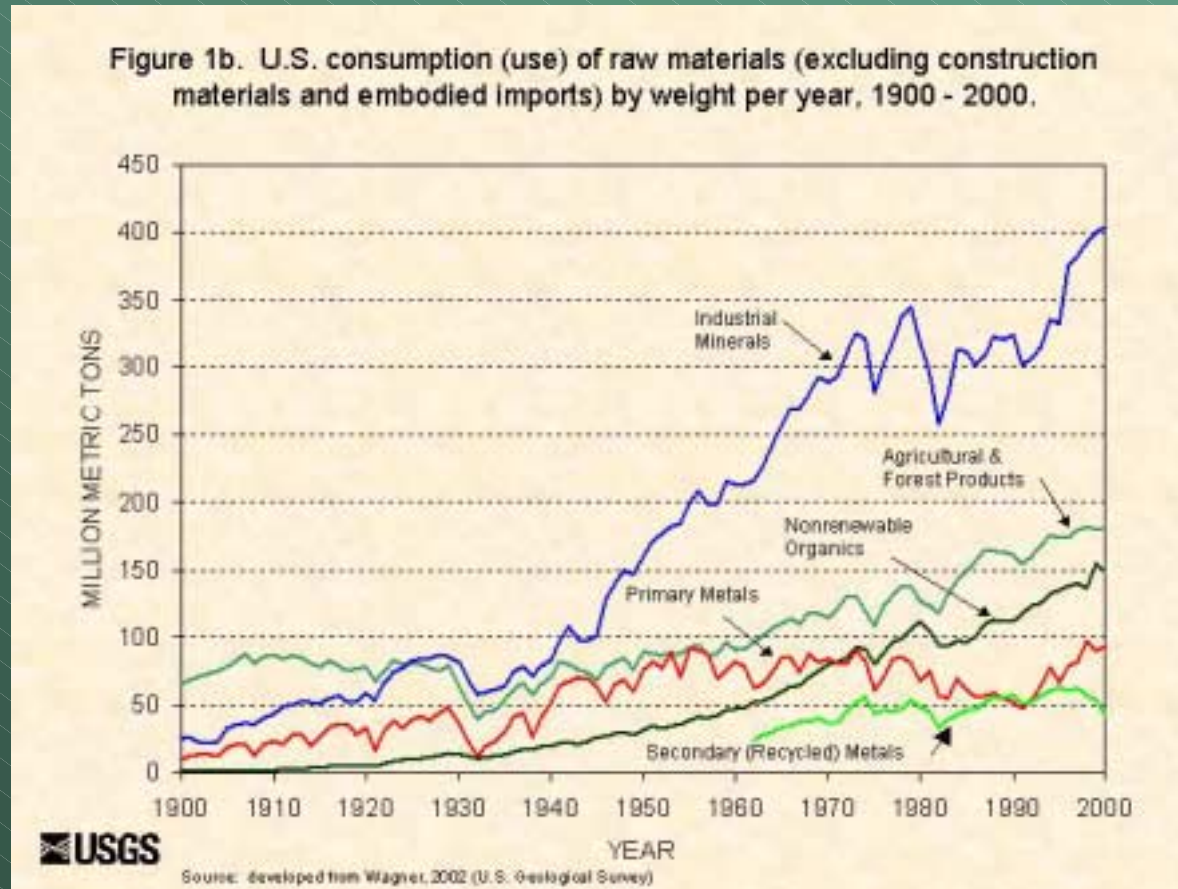
Figure 1a. U.S. consumption (use) of raw materials by weight per year, 1900 - 2000.
(excluding embodied imports)



USGS

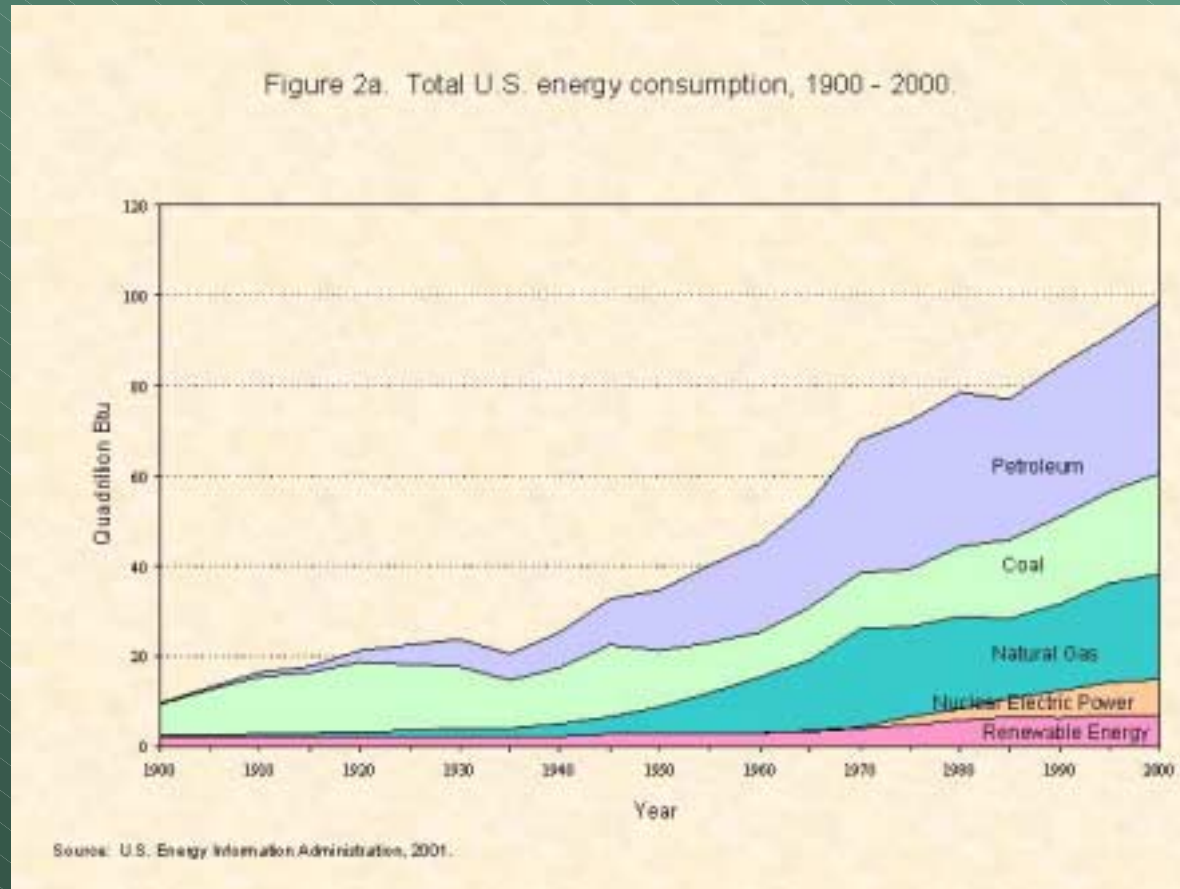
Source: Wagner, 2002 (U.S. Geological Survey)

Example Indicator — Consumption (use) of Mineral Commodities

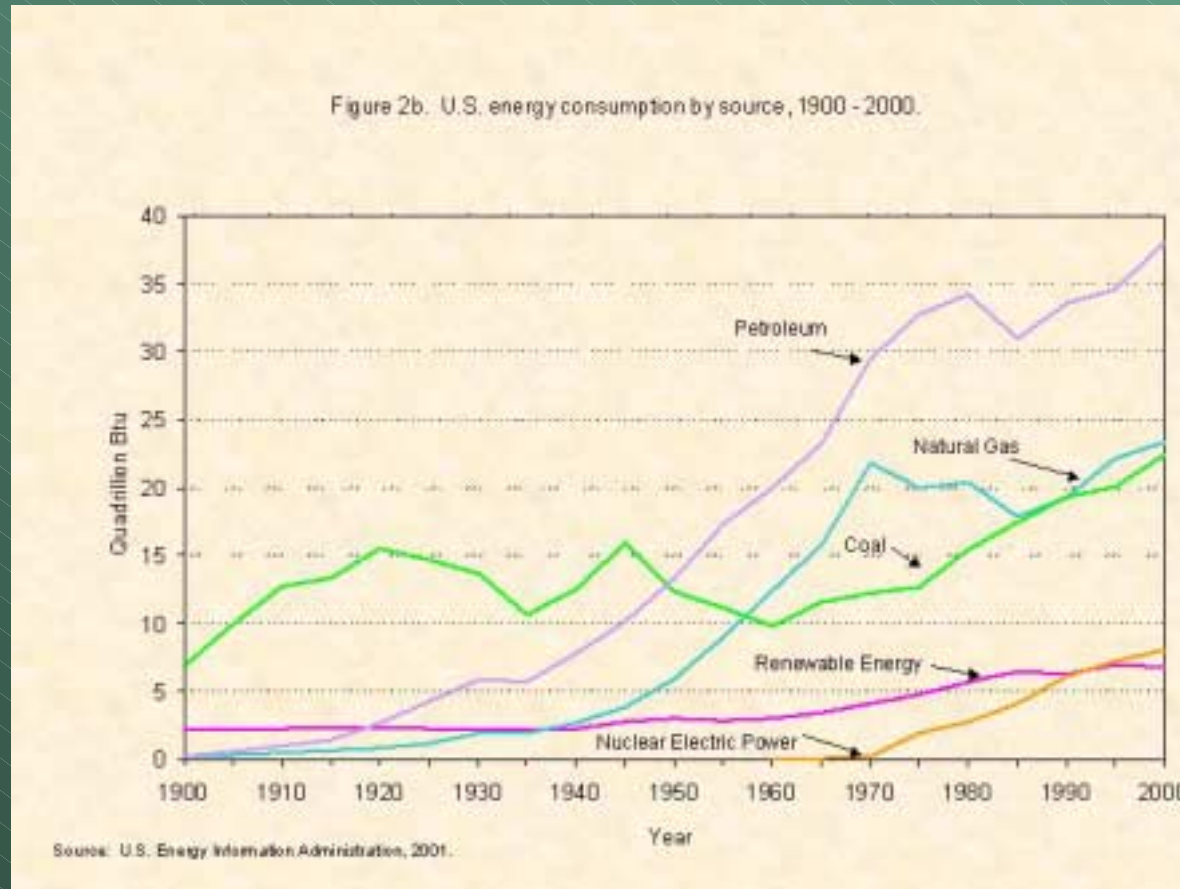


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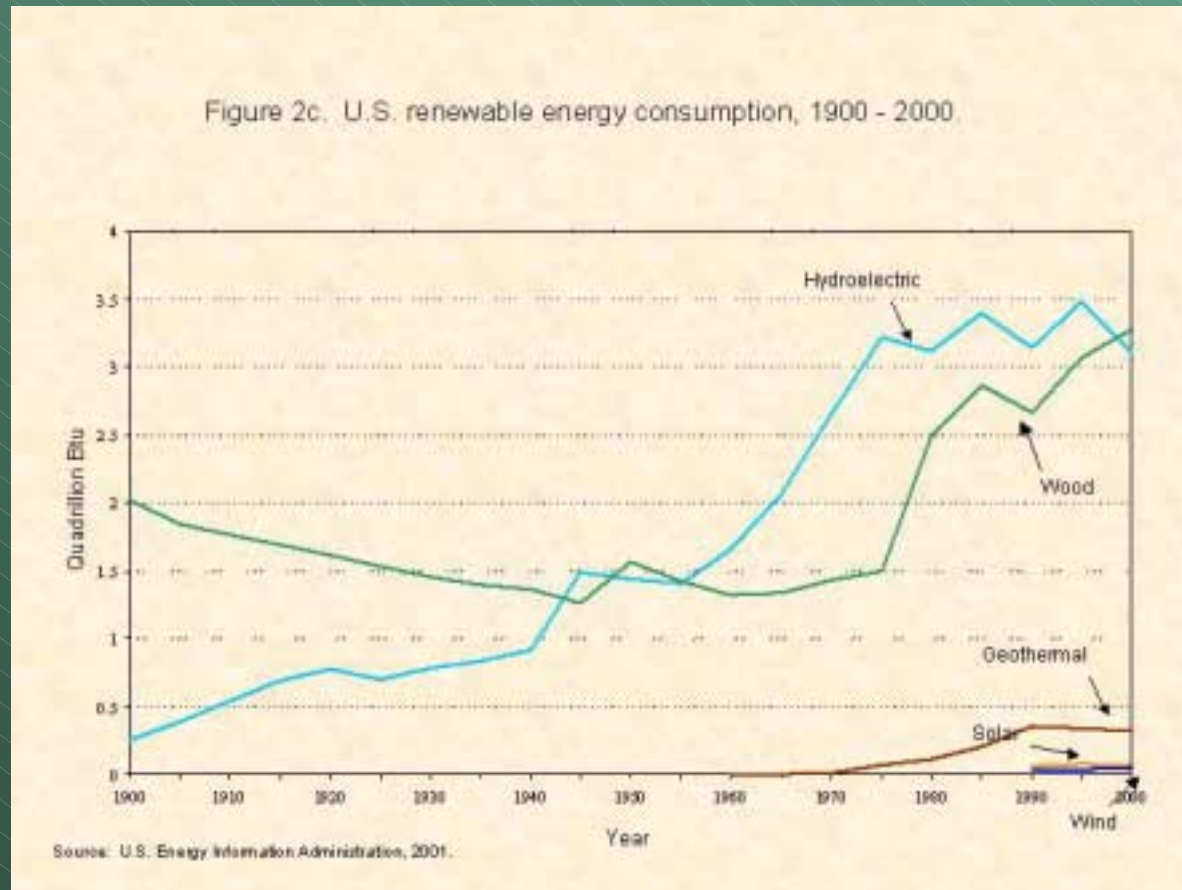
Example Indicator — Consumption of Energy Commodities



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Example Indicator — Consumption of Energy Commodities

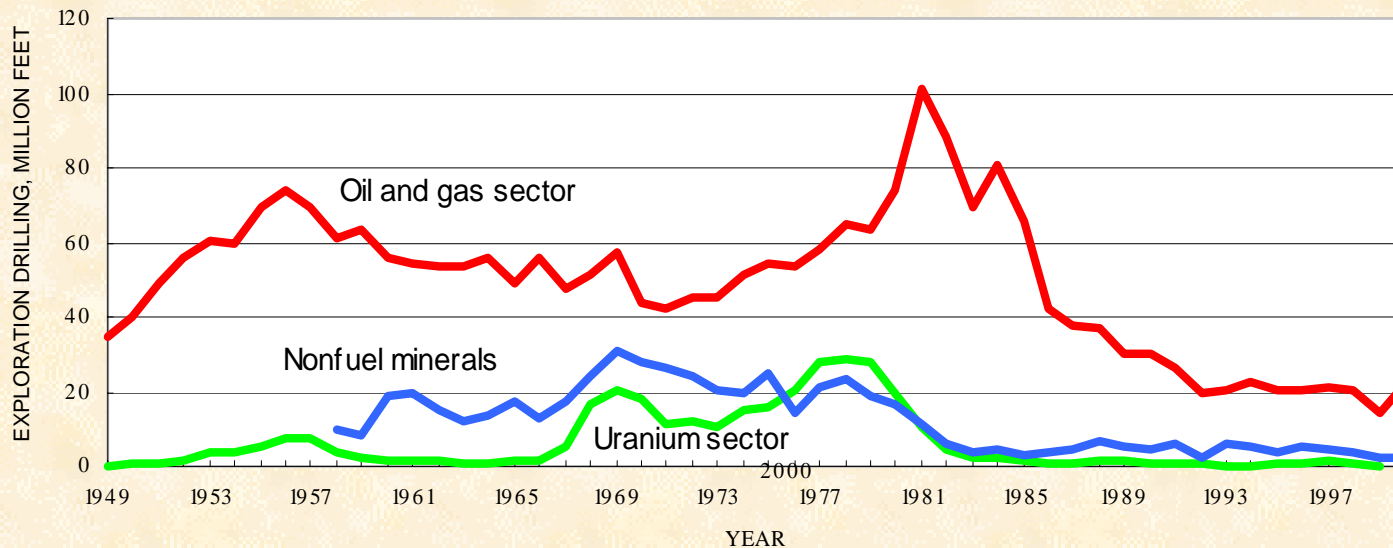


Example Indicator — Exploration Activity Over Time

- Exploration activity over time:
 - Annual drilling length.
 - Annual amount budgeted.
 - Discovery rate/dollar or level of effort expended.
 - Annual exploration rig utilization.
 - Annual domestic coal leases and licenses.
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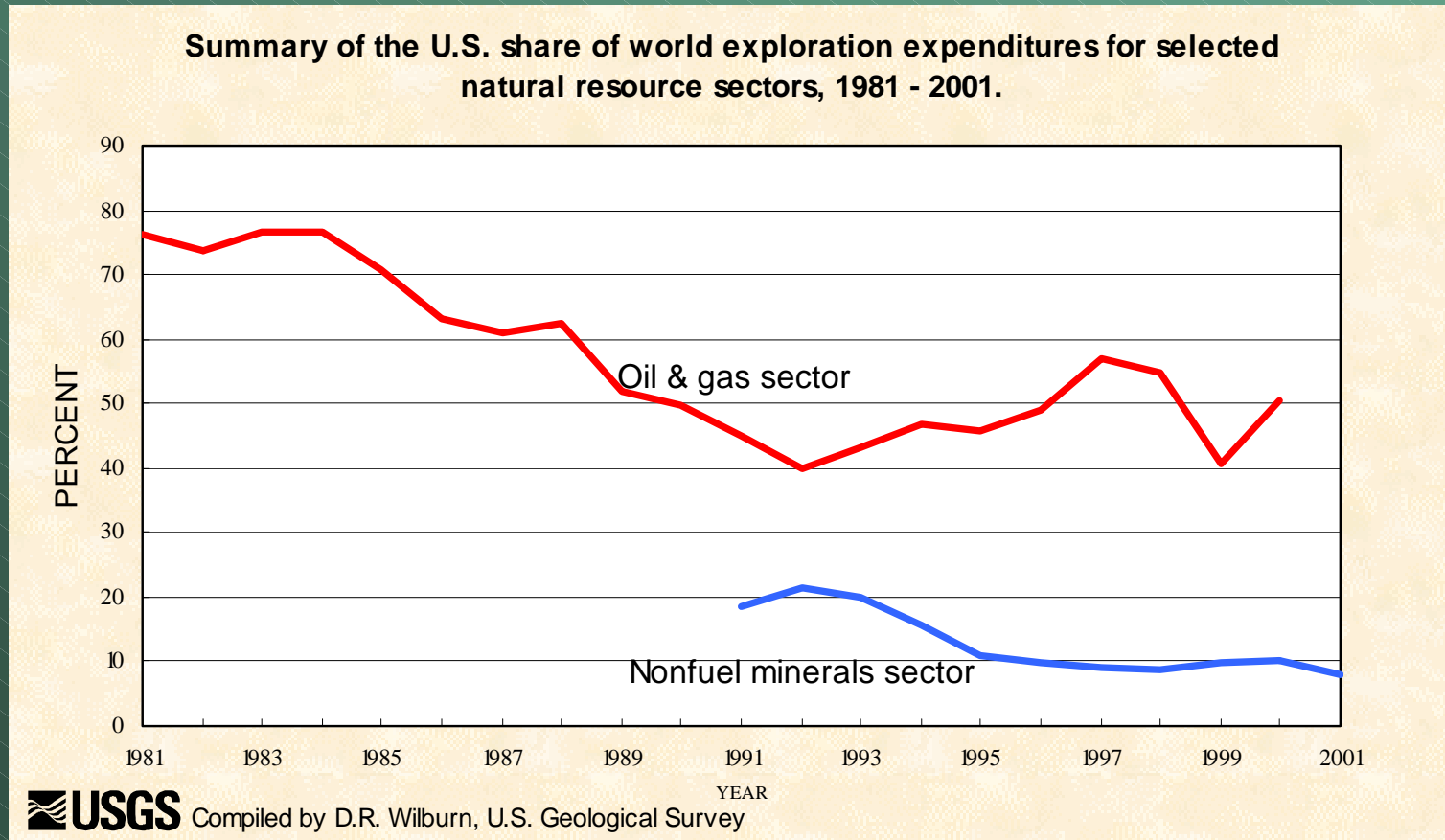
Example Indicator — Exploration Annual Drilling Length

U.S. exploration activity for selected natural resource sectors during the period 1949-2000, expressed by drilling length.

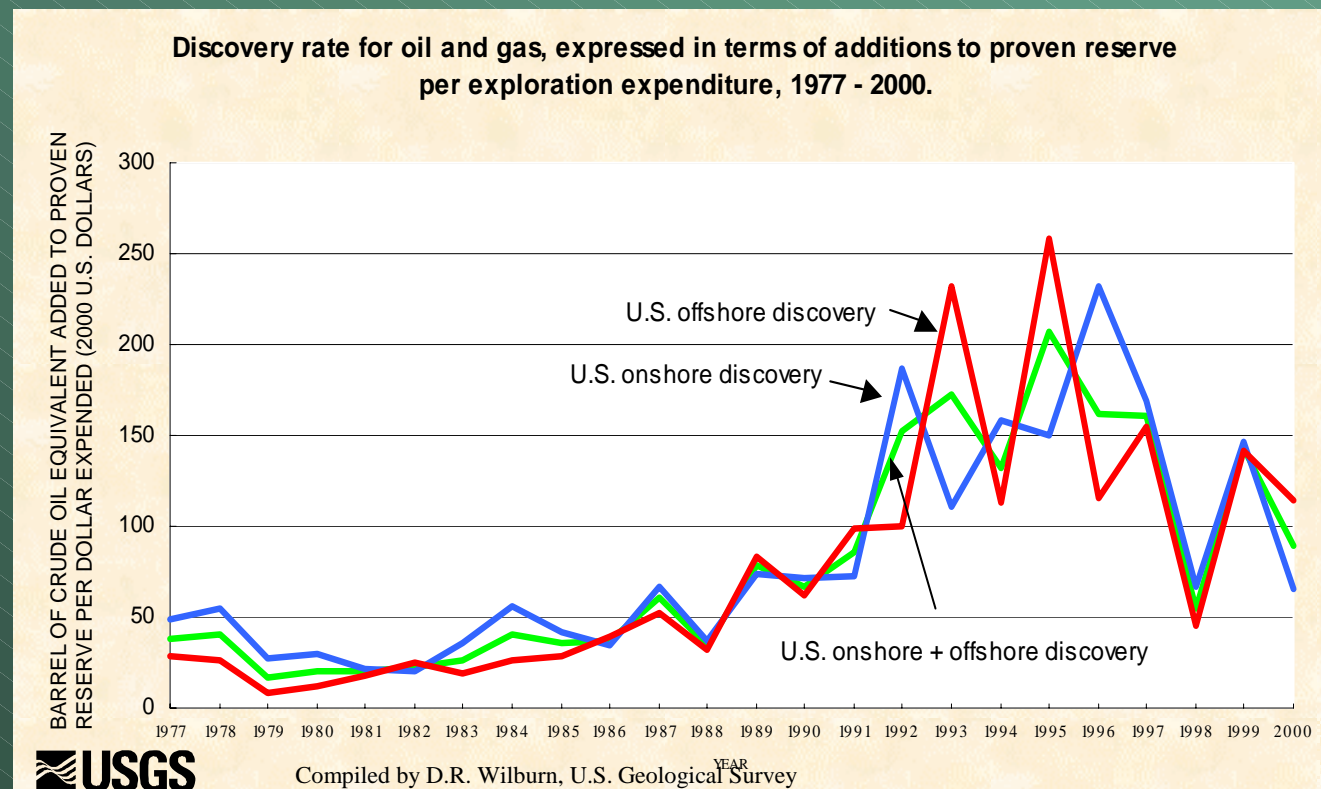


Compiled by D.R. Wilburn, U.S. Geological Survey

Example Indicator — Exploration Annual Amount Budgeted

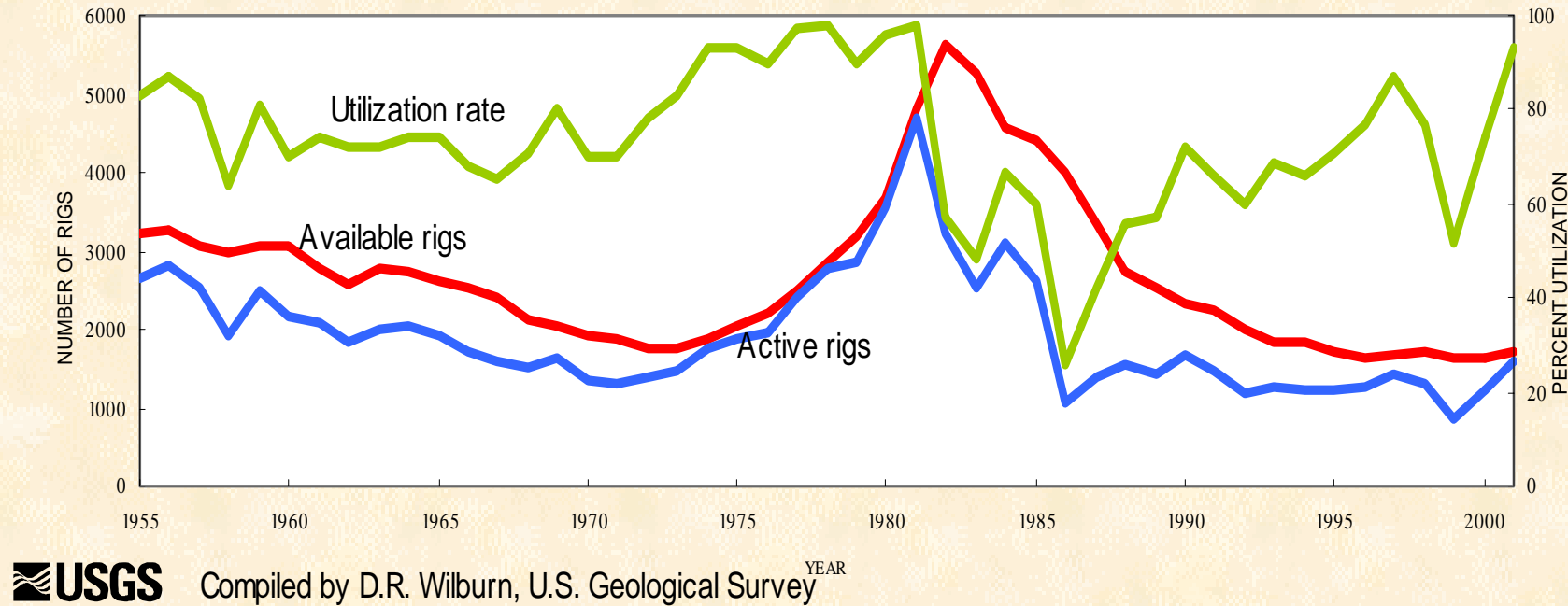


Example Indicators — Exploration Discovery Rate / Dollar of Exploration (Oil and Gas)

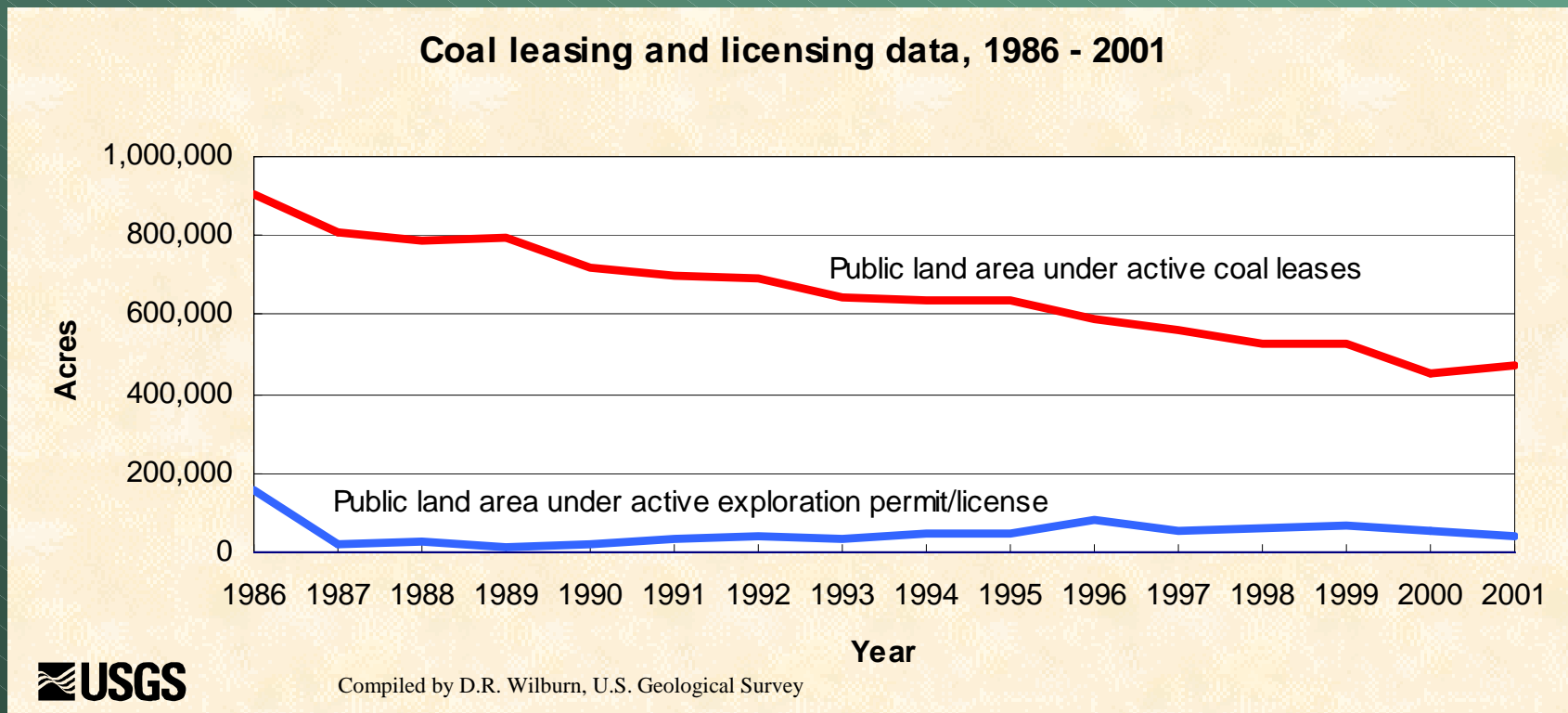


Example Indicators — Exploration Exploration Rig Utilization (Oil & Gas)

Available vs. active oil and gas rigs exploring in the United States, 1955 - 2000.



Example Indicators — Exploration Domestic Coal Leases and Licenses (Coal on Public Land)



Example Indicators

- **Additional indicators are under development.**