RESOURCE SECURITY: INTRODUCTION

WHAT IS RESOURCE SECURITY?

Resource security refers to the availability, accessibility, and sustainable management of natural resources (e.g. energy, water and minerals) to meet the present and future needs of societies. It is a crucial part of economic development, social stability and environmental sustainability.

Why does it occur? Resource insecurity arises when supply cannot meet demand, either due to physical scarcity, political barriers, or environmental degradation. As global populations grow and economies expand, pressure on resources intensifies, making resource security one of the key challenges of the 21st century.

CLASSIFYING RESOURCES

Resources can be classified based on their renewability and their usability:

Stock resources:

- Non-renewable and finite
- Formed over geological timescales and are consumed faster than they can be replaced
- E.g. Coal, oil, natural gas, metal ores

Flow resources:

- Renewable and naturally replenished on short timescales
- Continuous or cyclical, depending on natural cycles
- E.g. Solar, wind, hydroelectric power, biomass, tidal

Key distinction: Stock resources are exhaustible; flow resources are (in principle) sustainable if managed properly.

RESERVES AND RESOURCES

Resource: A naturally occurring substance that has potential value and is reasonably believed to exist.

Reserve: The portion of a resource that is economically viable to extract under current conditions.

Inferred resources: Believed to exist based on geological evidence but not yet proven or economically extractable.

WHY RESOURCE SECURITY MATTERS

Economic: Industries rely on consistent supplies of energy and raw materials. Scarcity increases costs.

Social: Inequitable access to resources often results in poverty and unrest.

Political: Resource-rich regions can use supplies as geo-political leverage (e.g. Russia's gas exports).

Environmental: Unsustainable resource exploitation leads to long-term damage (e.g. deforestation, pollution, biodiversity loss).

THE RESOURCE PEAK: HUBBERT'S CURVE

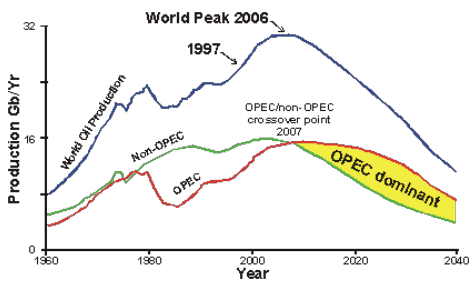
Resource production (especially for stock resources) often follows a bell-shaped curve known as Hubbert's Peak.

This model predicts that:

- Resource production increases with demand and technological improvements
- At a certain point, production hits a peak (maximum output)
- After the peak, production declines due to resource depletion and rising costs of extraction

Implications of the resource peak:

- Prices rise as availability falls
- Economic and political instability may increase
- There's a greater push for alternative resources and technologies



RESOURCE SECURITY: GLOBAL RESOURCE AVAILABILITY AND CONSUMPTION

GLOBAL PATTERNS OF RESOURCE AVAILABILITY

Natural resources are distributed unevenly across the world due to variations in geology, climate, topography, and ecosystems. This uneven distribution leads to disparities in access and dependence on certain resources.

Key influencing factors:

- Geology – determines the location of fossil fuels and metal ores, e.g. oil in the Middle East, copper in Latin America
- Climate – influences availability of renewable resources like solar and hydroelectric power, e.g. solar potential in North Africa
- Water availability – some areas like the Tibetan Plateau are water-rich, while others, e.g. Sahel region) face chronic water scarcity
- Infrastructure – developed countries often have the means to access and transport remote resources, unlike LDEs (low development economies)

RESOURCE INEQUALITY

Access to resources often reflects levels of economic development, political power, and technological advancement.

Implications of inequality:

- Resource-rich but poor – some countries possess valuable resources but lack the infrastructure or stability to exploit them efficiently, e.g. Democratic Republic of the Congo
- Resource dependency – countries dependent on imports are more vulnerable to global market fluctuations, e.g. Japan
- TNC dominance – transnational corporations often control extraction, pricing, and trade, sometimes undermining local economies

GLOBAL TRADE IN RESOURCES

Because of uneven distribution, many countries import and export energy and raw materials across long distances. Trade is vital for global economies. but introduces geopolitical and environmental challenges.

Key aspects:

- Stock resources – e.g. coal, oil, are bulky and expensive to transport
- Flow resources – e.g. electricity from renewables, are harder to trade but easier to decentralise
- Energy dependence – can lead to conflict, e.g. Europe's reliance on Russian gas
- Supply chains – can be disrupted by conflict, natural disasters, or political instability

GLOBAL PATTERNS OF RESOURCE CONSUMPTION

Early 21st century: The world remains heavily dependent on stock resources, particularly fossil fuels. Despite growth in renewable energy, consumption patterns remain unequal and environmentally unsustainable.

Key trends:

- Fossil fuels account for about 85% of global energy consumption
- High-income countries (HICs) consume disproportionately more per capita
- Emerging economies (EMEs) like China and India are increasing their consumption rapidly due to industrial growth and rising living standards
- Low-income countries (LICs) often have lower consumption but still face shortages and poor access to basic energy and water services

DRIVERS OF GROWING RESOURCE DEMAND

Demand for energy, water, and minerals is increasing due to:

- Population growth – more people require more resources
- Urbanisation – cities concentrate demand for water, energy, and building materials
- Economic development – industrialisation increases energy and material use
- Consumerism – as incomes rise, demand for energy-intensive goods increases, e.g. cars, air conditioning, meat, etc

RESOURCE SECURITY: ENERGY RESOURCE SECURITY

WHAT IS ENERGY RESOURCE SECURITY?

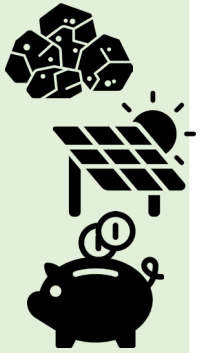
Energy resource security refers to the reliable, affordable, and sustainable access to energy sources needed for economic stability and social development. Without secure energy supplies, countries face disruptions to industries, public services, and domestic life. As the global population grows and economies expand, ensuring energy security becomes a critical global priority.

ENERGY MIX AND GLOBAL PATTERNS

An energy mix refers to the proportion of different energy sources used by a country. This mix is shaped by a combination of physical and human factors.

Influencing factors:

- Geology – determines access to fossil fuels, e.g. coal in China, oil in Saudi Arabia
- Climate – affects the potential for solar, wind, and hydro power
- Technology and infrastructure – enables the development and distribution of different energy forms
- Economic development – wealthier nations have the means to invest in energy diversification
- Policy and governance – governments influence energy strategy through subsidies, regulation, and international agreements



SUSTAINABLE ENERGY ALTERNATIVES

Increasing energy security in the long term requires a transition to sustainable and renewable energy sources. However, renewables have their own challenges:

Pros:

- Reduce dependency on imports
- Lower greenhouse gas emissions
- Infinite supply, if managed properly

Cons:

- High initial investment
- Intermittency, e.g. solar and wind are weather-dependent
- Land and environmental impacts, e.g. damming rivers for HEP

TYPES OF ENERGY SOURCES

Energy sources are categorised into primary and secondary types, and also into stock (non-renewable) and flow (renewable) resources.

Primary vs secondary energy sources:

- Primary energy sources – found in nature, e.g. coal, oil, sunlight, wind)
- Secondary energy sources – produced by converting primary sources, e.g. electricity from coal or HEP, petrol from crude oil

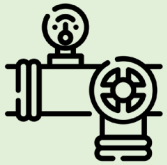
Stock vs flow resources:

- Stock resources – a finite and non-renewable, includes fossil fuels, e.g. coal, oil, and natural gas; nuclear fuel is also considered a stock resource (uranium)
- Flow resources – renewable and naturally replenished, includes wind, solar, geothermal, hydroelectric power, and biomass

RISKS AND THREATS:

- Overdependence – on single sources or suppliers, e.g. Europe's reliance on Russian gas
- Rising demand – from EMEs, e.g. India, China
- Finite fossil fuel reserves – leading to rising prices and political instability
- Environmental concerns – e.g. pollution and climate change from fossil fuel use
- Geopolitical tensions – especially where resources cross borders or involve conflict-prone areas

CASE STUDY: GAZPROM AND THE TRANS-SIBERIAN PIPELINE



- Gazprom is Russia's state-owned gas export monopoly
- Trans-Siberian pipeline, primarily known as the Power of Siberia gas pipeline, enables the export of natural gas from Russia to China
- Russia supplies a large share of Europe's natural gas
- Disputes with Ukraine have led to gas supply disruptions in several EU countries
- Construction of the Nord Stream pipeline bypassed Ukraine to reduce this risk

RESOURCE SECURITY: WATER RESOURCE SECURITY

WHAT IS WATER RESOURCE SECURITY?

Water resource security means having reliable access to sufficient, safe, and affordable water for drinking, agriculture, industry, and ecosystem support.
It is critical to public health, food security, economic development, and political stability.
Despite water covering 71% of Earth's surface, only 2.5% is freshwater, and much of that is locked in glaciers and aquifers.

GLOBAL PATTERNS OF WATER AVAILABILITY

Water is unevenly distributed across the globe, with some regions experiencing physical scarcity and others facing economic limitations in accessing available water.
Physical water scarcity: When natural water availability is insufficient to meet demand, e.g. the Sahel region in Northern Africa…
…Around 1.2 billion people live in areas of physical water scarcity.

Economic water scarcity: When water is available but poorly managed or inaccessible due to lack of infrastructure – this is widespread across rural areas in many African countries…
…Over 2.4 billion people lack access to safe sanitation, increasing water-borne diseases.

WATER STRESS AND SCARCITY

Water stress: When annual renewable water supplies drop below 1,700m³ per person.
Water scarcity: When water supplies drops below 1,000m³ per person.
Cities are especially vulnerable due to high population densities and infrastructure limitations.
Example: Greater London suffers from 'severe water stress' due to low rainfall and high demand.

FACTORS INFLUENCING WATER SECURITY

Several interrelated physical and human factors determine a region's water security…

- Climate – determines precipitation patterns; dry climates face higher scarcity, e.g. California
- Geology – permeable rocks, e.g. chalk, allow aquifers to form; impermeable areas rely on surface water

- Drainage – high drainage density increases water flow and availability
- Population growth – increases demand for drinking water, sanitation, and food production

- Urbanisation – concentrates water demand in cities
- Pollution – contaminates freshwater sources, e.g. industrial waste in rivers
- Agriculture – accounts for about 70% of global freshwater use (often inefficiently)

CHALLENGES TO WATER SECURITY

Over-abstraction: Excessive removal from aquifers causes land subsidence and saltwater intrusion.

Pollution: Industrial and agricultural waste contaminates rivers and groundwater.

Climate change: Alters rainfall patterns and increases droughts and floods.

Transboundary conflicts: Rivers crossing borders require cooperation, e.g. Nile, Ganges, Mekong.

CASE STUDY: THE MURRAY-DARLING BASIN, AUSTRALIA

- Supplies 75% of Australia's water for agriculture and supports 2 million people
- Suffers from variable climate, including floods and droughts linked to El Niño
- Faces conflicting demands from farmers, urban users, and environmental conservation
- Water abstraction upstream has permanently damaged wetland ecosystems at the river's mouth
- This basin highlights the tension between productivity, ecosystem health, and equitable water distribution

RESOURCE SECURITY: MINERAL RESOURCE SECURITY

WHAT IS MINERAL RESOURCE SECURITY?

Mineral resource security refers to the reliable and sustainable access to key mineral resources necessary for industrial production, technological development, and economic growth.

Modern technologies: Many of these depend on specific metals and minerals, making them strategically important, e.g. smartphones, electric vehicles, wind turbines and solar panels.

Global distribution: Minerals are unevenly distributed across the globe and are finite in supply, particularly in their high-grade forms.

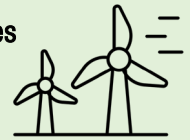
Issues: Increasing global demand and geopolitical tensions have made securing mineral resources a critical concern for many nations.

TYPES AND USES OF MINERALS

Minerals can be broadly classified based on their use in industry…

Base metals: Such as copper, lead, and zinc – used in construction and manufacturing.

Precious metals: E.g. gold and silver – valued for rarity and often used in electronics and jewellery.



Rare earth elements: Crucial for modern technologies such as neodymium in wind turbines and magnets.

Industrial minerals: E.g. limestone and phosphate – used in agriculture and building.

Example – copper:

- Durable, conductive, and recyclable.
- Essential for wiring, motors, electronics, and renewable energy infrastructure.
- Highly demanded by manufacturing giants, especially China, which consumes over 40% of global supply.

GLOBAL DISTRIBUTION AND TRADE OF MINERALS

Mineral resources are found in various geological formations, including:

- Cratons and shields – e.g. Baltic Shield, Canadian Shield
- Fold mountains – where mineral veins are concentrated.
- Sedimentary basins and river deposits – for alluvial gold and other minerals

Global distribution:

- Latin America (especially Chile and Peru) dominates global copper production
- Africa holds vast untapped reserves of critical minerals, often hindered by political instability
- Most processing and refining occurs in HICs or major EMEs like China, creating global trade interdependence

CHALLENGES IN MINERAL RESOURCE SECURITY

Geopolitical risks:

- Governments may restrict exports or nationalise industries (e.g. Bolivia, DRC).
- Conflict minerals – mining in war-torn regions (e.g. cobalt in the DRC) raises ethical concerns.

Environmental and social impacts:

- Deforestation, pollution, and ecosystem destruction from open-cast mining
- Toxic runoff and tailings can contaminate groundwater and rivers

- Displacement of communities and poor labour conditions

Resource depletion:

- High-grade ores are being exhausted
- Future extraction will require deeper, more expensive, and environmentally damaging methods

CASE STUDY: KENNECOTT BINGHAM CANYON MINE, USA

- One of the world's largest copper mines.
- Located in Utah, it's 4.5km wide and 1.2km deep
- Owned by Rio Tinto, employing 2,000 people and producing around $1.8 billion in metals annually

- Known for its efforts in land reclamation and community integration, e.g. creation of the Daybreak sustainable community).

Environmental management:

- Dust suppression by spraying roads
- Tailings ponds capped with topsoil and revegetated
- Smelting gases used to create sulphuric acid – reducing air pollution

RESOURCE SECURITY: ENVIRONMENTAL AND SOCIAL IMPACTS OF RESOURCE USE

A DELICATE BALANCE!

Natural resource exploitation fuels global economic growth, but it often comes at a high environmental and social cost. Mining minerals, extracting fossil fuels, or diverting rivers for water, can all lead to significant degradation of ecosystems and the displacement or exploitation of human populations.

Resource security goes hand in hand with environmental sustainability and social justice.

ENVIRONMENTAL IMPACTS OF RESOURCE EXPLOITATION

Deforestation and land degradation:

- Resource extraction often involves the clearing of forests for access to mineral reserves or for building dams and infrastructure
- Soil erosion and loss of biodiversity follow, especially in tropical regions
- Example – copper mining in South America and bauxite mining in West Africa have led to widespread vegetation loss

Pollution:

- Air pollution – smelting releases toxic gases, e.g. sulphur dioxide
- Water pollution – runoff from mines contains heavy metals and acids, contaminating rivers and groundwater
- Thermal pollution – e.g. power plants and industrial discharges alters aquatic ecosystems
- Example – acid mine drainage from abandoned mines continues to pollute waterways decades after closure.

Climate Change:

- Fossil fuel combustion releases greenhouse gases (GHGs), driving the enhanced greenhouse effect.
- Methane leaks during oil and gas extraction are potent contributors to global warming.
- Energy-intensive resource extraction (like tar sands or deep-sea mining) increases carbon footprints.

SOCIAL IMPACTS OF RESOURCE USE

Displacement of communities:

- Large infrastructure projects, e.g. dams or open-pit mines often require the relocation of entire villages
- Resettlement can be poorly managed, e.g. inadequate compensation/support
- Example – the Lesotho Highlands Water Project displaced thousands of people and affected farmland and livelihoods

Health and safety risks:

- Communities near extraction sites face exposure to toxic pollutants, contaminated water, and hazardous air
- Miners often work in unsafe conditions, especially in informal or illegal operations
- Example – in parts of Sub-Saharan Africa, artisanal miners face high rates of injury and exposure to mercury

Conflict and inequality:

- Resources can lead to conflict, particularly in politically unstable regions where 'resource grabs' take place
- The term 'resource curse' is the paradox where countries rich in resources often experience corruption, inequality, and slower development
- Example – control over diamond and cobalt mining has contributed to prolonged conflict in the Democratic Republic of Congo

SUSTAINABLE RESOURCE MANAGEMENT

Environmental impact assessments (EIA): To forecast and mitigate damage before projects begin.

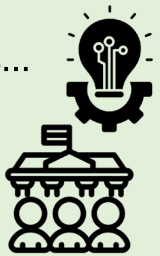
Sustainable mining techniques: E.g. backfilling pits, recycling water and reducing energy use.

Community consultation and benefit-sharing: To ensure local populations are respected and involved.

International standards and certifications: E.g. Fairtrade Gold or the Extractive Industries Transparency Initiative (EITI).

RESOURCE SECURITY: TECHNOLOGICAL AND POLITICAL FACTORS

HUMAN INFLUENCE ON RESOURCE SECURITY



Resource security is not just about the physical presence of resources…

Technology: Plays a crucial role in discovering, extracting, and using resources more efficiently.

Politics: Political decisions determine access, trade, and international cooperation or conflict. Together, these factors can either enhance or undermine a country's ability to secure the resources it needs.

TECHNOLOGICAL INNOVATIONS IN RESOURCE MANAGEMENT

Technological advancement has reshaped how we locate, extract, and consume resources…

Exploration technologies:

- Remote sensing, satellite imagery, and geological modelling help locate underground reserves
- Seismic surveys are used in oil and gas exploration to assess sub-surface structures

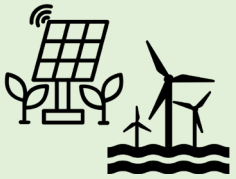
Extraction and Processing:

- Techniques like fracking (hydraulic fracturing) have unlocked previously inaccessible shale oil and gas reserves
- Bioleaching and phytomining allow for metal extraction with reduced environmental damage

Efficiency and recycling:

- Innovations in recycling and material efficiency help reduce the pressure on primary resources
- Electric vehicle battery recycling and urban mining (recovering metals from electronics) are growing fields
- E.g. recycling copper uses 85% less energy than primary extraction

Renewable energy technology



- Developments in solar panels, wind turbines, energy storage, and smart grids have improved the viability of flow resources
- Hydrogen fuel and carbon capture and storage (CCS) offer potential for cleaner fossil fuel use

POLITICAL CONTROL AND GOVERNANCE

Governments play a central role in regulating how resources are used, managed, and distributed.

Regulation and policy: Environmental protection laws limit pollution and require rehabilitation of mined land. Subsidies and tax incentives can encourage or discourage certain energy sources, e.g. UK Climate Change Levy.

Resource nationalised: Some governments restrict exports or nationalise industries to retain control over resources, e.g. Venezuela and Bolivia have nationalised oil and gas industries to protect domestic interests.

Trade agreements and tariffs: Bilateral or multilateral agreements facilitate the trade of energy, water, and minerals. Tariffs can protect local industries but may increase global tension.

GEOPOLITICS AND RESOURCE SECURITY

Access to key resources can lead to geopolitical power plays, especially where supply routes cross multiple borders.

Key examples:

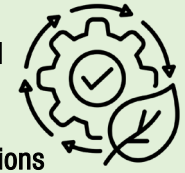
- Gazprom and Russia's gas pipelines – Russia's control over gas exports to Europe has been a recurring source of political tension, particularly involving Ukraine
- China's dominance in rare earth elements – over 80% of rare earth processing occurs in China, giving it strategic control over global high-tech supply chains

Strategic responses:

- Countries diversify suppliers or invest in domestic alternatives
- The EU and USA have increased stockpiling and are supporting new mines and refineries for critical minerals

RESOURCE SECURITY: RESOURCE MANAGEMENT AND SUSTAINABILITY

SUSTAINABLE RESOURCE MANAGEMENT



As global demand for resources rises the risk of environmental degradation, conflict, and long-term scarcity also rises. Sustainable resource management aims to meet the needs of the present without compromising the ability of future generations to meet their own – balancing environmental protection, economic development, and social equity (the three pillars of sustainability).

PRINCIPLES OF SUSTAINABLE RESOURCE MANAGEMENT

1. Environmental stewardship:

- Ensures that ecosystems are preserved and biodiversity protected
- Requires careful monitoring of pollution, emissions and resource extraction
- Promotes the protection of water sources, forests, and mineral-rich lands

2. Economic viability:

- Encourages efficient use of resources to maximise benefits
- Supports investment in innovation, green technology and recycling industries
- Generates long-term jobs and revenue without depleting resources

3. Social responsibility:

- Ensures that resource development benefits local communities
- Prioritises health, safety, and fair labour conditions
- Promotes community engagement and conflict prevention

SUSTAINABILITY TOOLS AND APPROACHES

Environmental impact assessments (EIAs): Evaluate the potential impacts of a project before development begins.

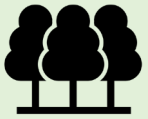
Abstraction licences: In the UK, water users must pay for rights to extract groundwater.

Virtual water trade: Importing water-intensive goods, e.g. fruit, to reduce stress on local water supplies.

Composting toilets: Sustainable sanitation option trialled by WaterAid in countries like Mozambique.

STRATEGIES FOR MANAGING RESOURCES SUSTAINABLY

Catchment and water management:



- Restoring wetlands and forests to improve natural water catchment
- Encouraging efficient irrigation and farming practices to reduce water loss
- Promoting water-saving infrastructure e.g. greywater recycling systems

Energy efficiency:

- Using energy-efficient technologies, e.g. LED lighting, low-energy appliances
- Investing in smart grids and decentralised energy systems e.g. Combined Heat and Power (CHP)

- Promoting clean alternatives such as solar, wind, and hydroelectric power.

Material recycling and re-use:

- Recycling metals like aluminium, copper, and steel reduces demand for mining
- Urban mining (recovering precious metals from electronic waste) is gaining importance
- Composting and circular economies help reduce landfill use and promote reuse

Sustainable mining practices:

- Reclamation – restoring land after mining operations end
- Tailings management – containing and stabilising mining waste to prevent pollution
- Example – Kennecott Bingham Canyon Mine has implemented land restoration and dust control

CASE STUDY: THE RÖSSING URANIUM MINE, NAMIBIA

Operated by Rio Tinto – great example of sustainable resource management in action…

Environmental:

- Water use is tightly managed due to scarcity
- Dust is controlled through continuous spraying
- Wastewater is treated and reused

Economic:

- Employs a 98% Namibian workforce
- Offers training, full-time contracts, and supports local development through the Rössing Foundation

Social:

- Built the town of Arandis for workers, with healthcare, education and shops
- Conducts regular health checks for radioactive exposure

RESOURCE SECURITY: CONTEMPORARY ISSUE AND CASE STUDIES

CONTEMPORARY GLOBAL ISSUES IN RESOURCE SECURITY

Climate change: Increases droughts, floods, and resource instability. Alters rainfall patterns and disrupts crop and hydropower productivity.

Geopolitical conflict: Resource disputes between countries, e.g. the Nile Basin and South China Sea. Control over oil, gas, and water can be used as political leverage.

Shale gas revolution: Advances in fracking have reduced U.S. dependence on imports. Raises environmental concerns like groundwater contamination and seismic activity.

Environmental justice: Poor and indigenous communities often suffer most from exploitation – needs fairer, more inclusive decision-making.

CASE STUDY: THE LESOTHO HIGHLANDS WATER PROJECT (LHWP)

Lesotho – mountainous country surrounded by South Africa, with a water surplus (low population/high rainfall). Largest water transfer scheme in Africa – 6 major dams and 200km of tunnels transfer water from Lesotho to South Africa (takes 40% of Senqu river water).

Purpose:

- Transfers water from Lesotho's highland dams to supply in South Africa.
- Also provides hydroelectric power for Lesotho

Benefits:

- Lesotho earns revenue from water exports – around $1.5 million a month about 75% of country's income
- South Africa (Gauteng Province) gains water security in a dry, urbanised region

Problems:

- Displacement of communities
- Loss of farmland and wildlife habitat
- Environmental degradation of the Senqu River

CASE STUDY: CALIFORNIA'S WATER CRISIS, USA

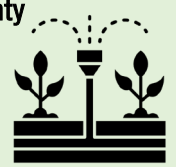
California is one of the world's most agriculturally productive regions, yet it faces chronic water shortages.

Key features:

- Population – 39 million people
- 80% of water used for agriculture (often for water-intensive crops like almonds)
- Receives most rainfall in the north, but the largest demand is in the south

Issues:

- Spatial mismatch – water falls in the north but is needed in the south.
- Drought – experienced 4 consecutive years of drought by 2015
- Over-reliance on aquifers – excessive groundwater abstraction has caused subsidence
- Pollution – contaminated wells, especially in areas like Los Angeles County



Management:

- State-wide water transfer schemes
- Mandatory 25% usage reduction in 2015
- Investment in greywater systems, efficient irrigation, and desalination

CASE STUDY: CHINA'S ENERGY MIX AND SECURITY

China is the largest global consumer and producer of energy, yet it remains energy insecure.

Energy profile:

- Relies heavily on coal (over 60% of electricity generation)
- Largest emitter of greenhouse gases
- Major investor in renewables, especially solar and HEP (Three Gorges Dam)

Challenges:

- Remote coal reserves require long-distance transport
- Environmental degradation and air pollution from coal
- Dependence on imported oil and gas raises geopolitical concerns

Solutions:

- Diversifying the energy mix (wind, solar, nuclear)
- Decentralised energy systems and smart grid development
- International investment in foreign energy assets (e.g. in Africa and Central Asia)