Regional Sustainability Planning: Energy Focus

Presentation at Chungnam Development Institute

Young-Doo Wang
Professor Emeritus
Center for Energy and Environmental Policy
University of Delaware

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University of Delaware
http://ceep.udel.edu

Local Agenda 21

- ***"Each Local Authority should enter into a Dialogue with its Citizens, Local Organizations and Private Enterprises and adopt a 'Local' Agenda 21."***
- ***Sustainability Plans (or Local Agenda 21) require two Central Approaches: Integrated Planning and Community Participation, developing Policies to reduce the Metabolic Flows in Local Areas***
- ***More than 2,000 Local Governments in the United States have implemented the Agenda since the 1992 Rio conference***

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Regional Environmental Dynamics

Resources:

Human and Natural Resources

Processes:

Manufacturing, Transportation, Construction, Migration and Population Growth

Effects:

Negative (Pollution, Wastes, etc.) and Positive (Value Added Products and Services, Education, Health, etc.)

(Srinivas, 1999)

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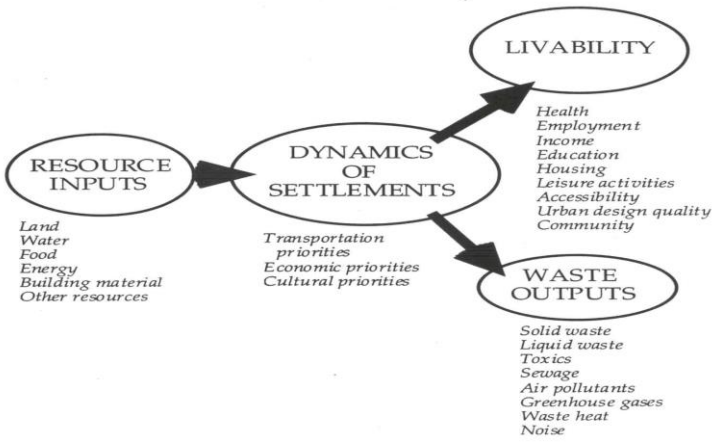
Extended Metabolism Model of Human Settlements

(Newman et al. 1999)



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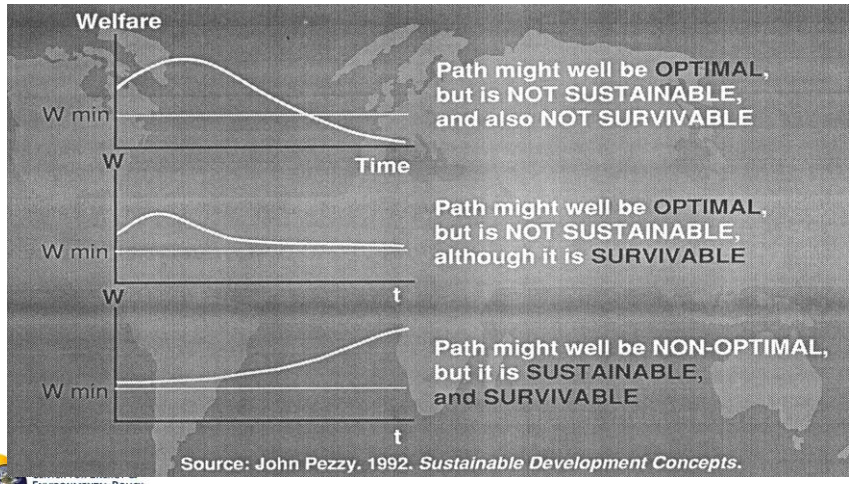
Optimality, Survivability and Sustainability



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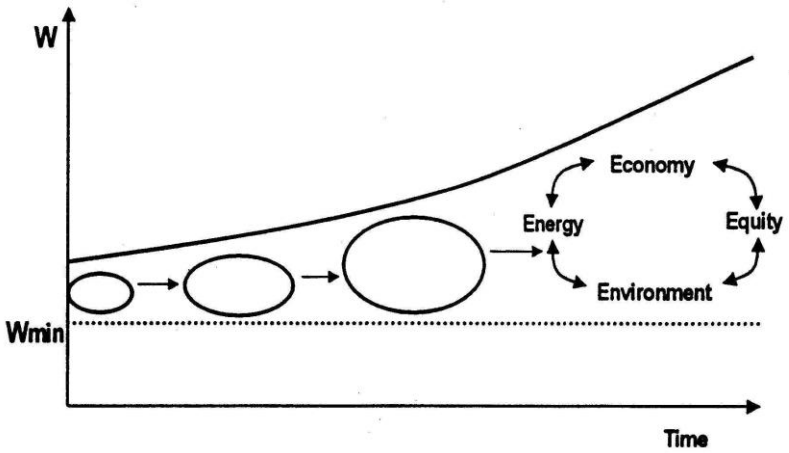
A Framework of Sustainable Development: Integration of Time and E^4

(Wang, 2001)



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Conventional vs. Sustainable Development Models: Economy

Conventional Growth Model	Sustainable Development Model
Goal: Profit Maximization	*Goal: long-term Development/Viability*
Commodity/Supply-side oriented	*End-Use oriented*
Consumption driven	*Consumption/Conservation in Balance*
Resources are seen as "Factors of Production"	*Resources are seen as limited, requiring Stewardship*
Resource-intensive, governed by Economic Priorities	*Resource-conserving, governed by Multiple Priorities*
Urban/Industrial-based Centers of Production	*Regionally dispersed Centers of Production*
Economic Costs are primary	*Economic Costs balanced by Social and Environmental Consideration*
Globalization	*Regionalization*

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Conventional vs. Sustainable Development Models: Energy

Conventional Growth Model	Sustainable Development Model
Fossil Fuel-and Nuclear Based	*Greater Use of Alternative Energy Sources*
Goal: to secure Abundant, Low Cost Energy Supply	*Goal: to secure End-Use Efficiency and Renewables*
Reduce Vulnerability by Diversifying Sources of Supply	*Reduce Vulnerability by Reducing Energy Intensity*
Energy/Technology-Focused	*Energy/Environment Conservation-Focused*
Efficiency of Economic Production *Economies of Scale* *Technical Efficiency*	*Efficiency in End-Use/Energy Services* *Modularity* *Energy Efficiency*
Centralized Energy System	*Decentralized Energy System*

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Conventional vs. Sustainable Development Models: Environment

Conventional Growth Model

Ecological assumption: human dominates the environment
Environment as an inexhaustible resource mine and a bottomless repository of wastes
Environmental impacts as external to economic choice
Use strategy: intensive, governed by economic profitability
Environment within society/ economy

Sustainable Development Model

Ecological assumption: human/environment are mutually dependent
Environment as exhaustible, but sustainable resources

Environmental impacts as central and internal to economic choice
Use strategy: selective, governed by conservation principle
Society/economy within environment

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Conventional vs. Sustainable Development Models: Equity

Conventional Growth Model	Sustainable Development Model
Short-term Utility Maximization	*Intergenerational Equity*
'Want' Driven Consumption	*Basic Human 'Needs' Driven*
Big pie first-Distribution next	*Distributional Equity*
Expert-Dominant Decision Making	*Public Participation in Decision Making*
Deterioration of Community Livelihood	*Community-Culture Based Approach*
Unevenness of Globalization	*Global Achievement of Environment and Development ends; Regionalization*
Funding for giant Infrastructure Projects	*Funding for Health, Education, and Social Priorities*
Efficiency driven	*Social Justice and fair Distribution*

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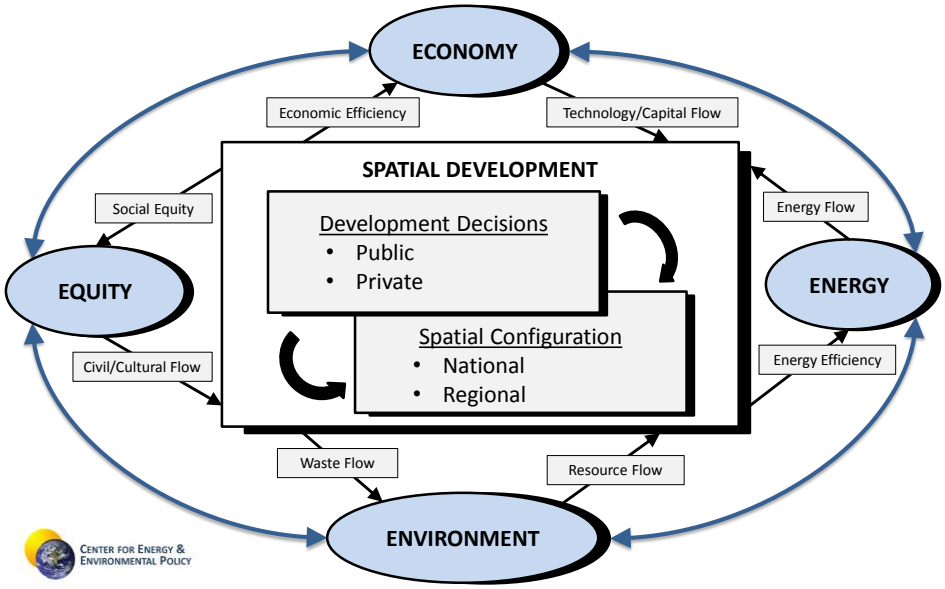
Framework of Spatial Configuration: Development Decisions within the Context of E^4



Sustainability: E^4

"The Linkages between Energy Systems and Economic Development, Social Equity, and Environmental Protection indicate that a Change in present Energy System is required if Sustainable Development Pathways are to be realized."

(Johansson, 2005)

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Sustainable Development and Sustainable Energy System

Sustainable Energy System is an Instrument for Sustainable Development

AND

Sustainable Energy System cannot be Achievable without a Sustainable Development System

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Why Alternative Energy?

- ***Empirically, Global Demand for Fossil Fuels is growing, and Fossil Fuels have Limited Supply and are Nonrenewable*** ***(Simon, 2007)***
- ***Question about: Claims of Low-Carbon Emissions over the Total Nuclear Fuel Cycle and Life Cycle of the Plant, as well as Assertions about Cost-Effectiveness and Safety*** ***(Saul et al., 2014)***

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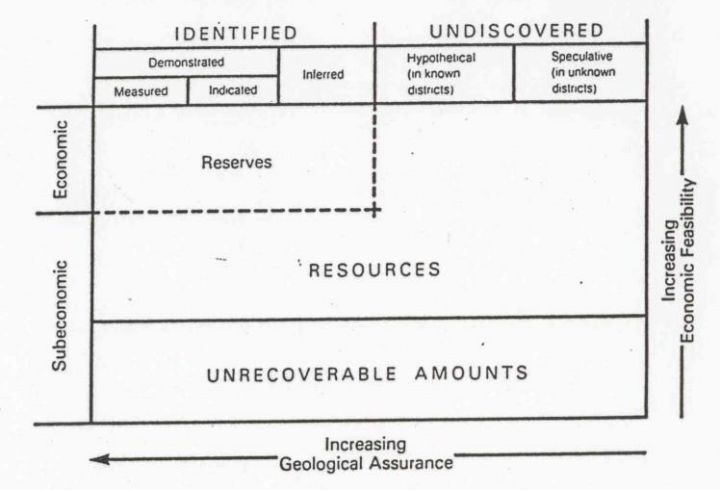
Resource vs. Reserve
Resource Base



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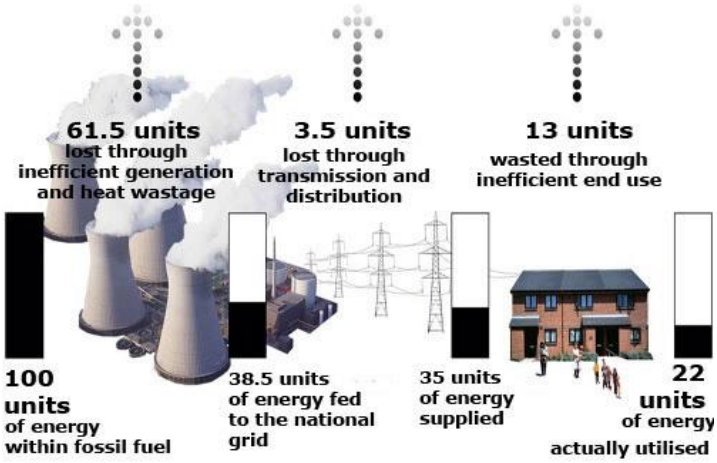
Life Expectancy of Petroleum Reserve: Based on the Global Annual Consumption of 30 Billion Barrels

Oil Reserve (Billion Barrels)	Annual Consumption Growth	
	3%	5%
2,000	37.2 Yrs.	24.7 Yrs.
5,000	54.4	43.5
10,000	77.9	57.7
20,000	101.3	71.9

Low Efficiency of Fossil Fuel Electric System



Source: Greenpeace, 2005

Inefficiency in Electricity Generation

For Every Three Units of Coal or Other Fossil Fuels to Generate the Power, only One Unit is Deliver to Homes and Business in the Form of Electricity

(Efficiency around 33%)

- ***Our Current Level of Efficiency is essentially unchanged since 1960***
- ***What the U.S. Wastes in the Generation of Electricity alone is more than Japan needs to power its Entire Economy***
- ***More Efficient Power Plants and Distributed Generation (DG) can boost its Efficiency to nearly 50%, saving about 10 Quads of Energy – about the Amount South Korea now uses***

(ACEEE, 2012)

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Global Mean Temperature

- ***According to the 2007 IPCC Report, Mean Global Surface Temperature has increased by 0.74º C over the last 100 Years (1906-2005)***
- ***Without Mitigating Policies, the Global Average Temperature is likely to rise by 2.6-4.8º C by 2100 from Pre-Industrial Level*** ***(IPCC, 2014)***
- ***11 of the Warmest Years on Record occurred during the Past 12 Years*** ***(IPCC, 2007)***

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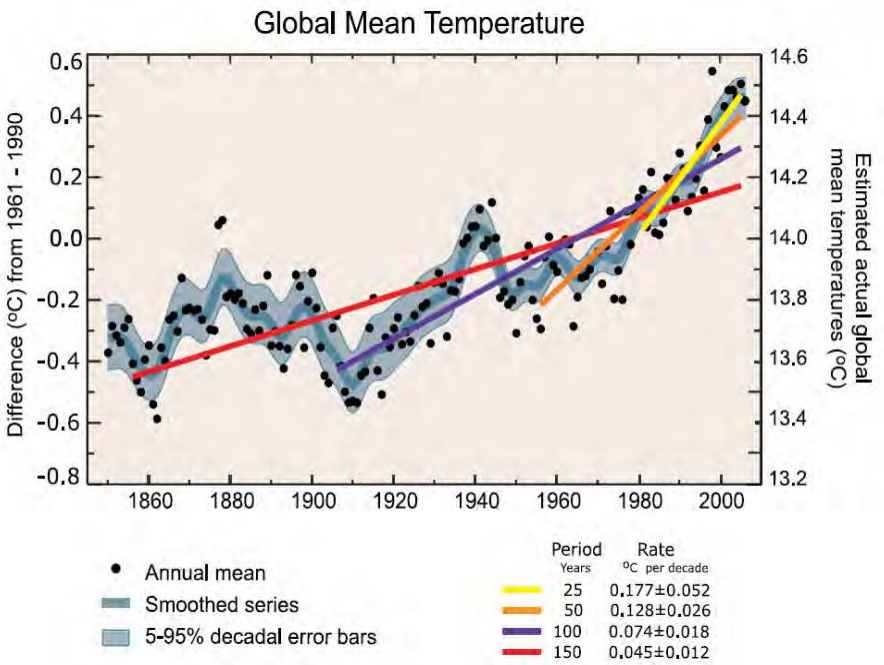
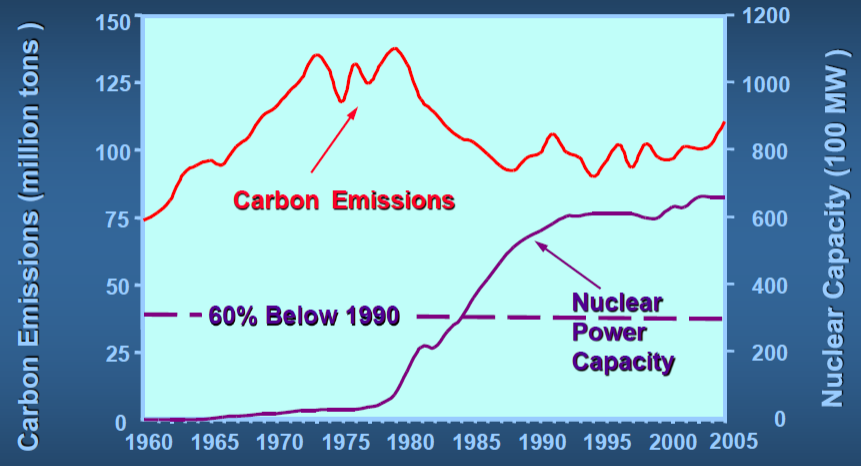


CO_2 Emissions and Nuclear Power France's Experience



Sources: ORNL, 2006; IAEA, 2002-2006

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Marginal Levelized Cost of Electricity for Different Generators

($2007 ¢/kWh) in the United States

Technology	Marginal Levelized Cost
Offshore wind	2.6
Hydroelectric	2.8
Biomass (MSW gas)	4.1
Onshore wind	5.6
Geothermal	6.4
Integrated gasification combined cycle	6.7
Biomass (combustion)	6.9
Scrubbed coal	7.2
Advanced gas and oil combined cycle	8.2
Gas oil combined cycle	8.5
IGCC with carbon capture	8.8
Parabolic troughs (solar thermal)	10.5
Advanced gas and oil combined cycle with carbon capture	12.8
Solar ponds (solar thermal)	18.8
Nuclear	**24.0**
Advanced combustion turbine	32.5
Combustion turbine	35.6
Solar photovoltaic (panel)	39.0

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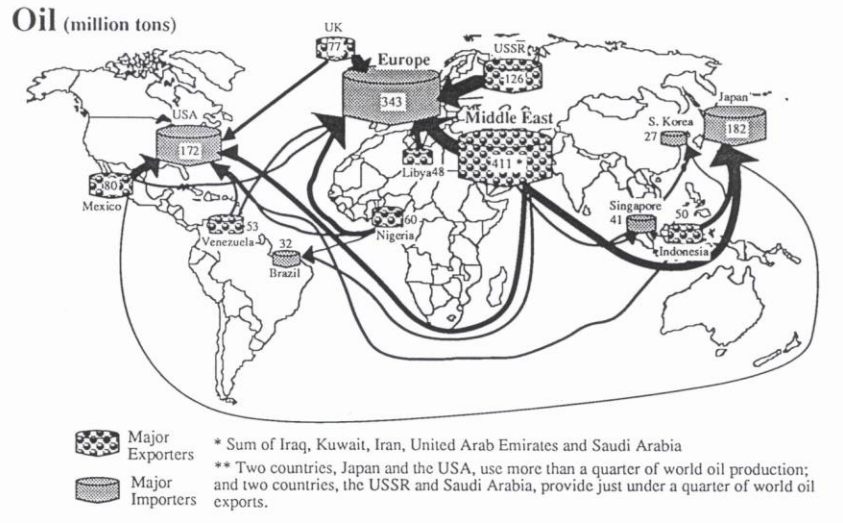
Source: Sovacool, B.K. (2009)

Resource Endowments: International Movement of Oil



Vulnerable to Climate Change

- ***Most Thermal Power Plants (fossil and nuclear) are located in low-lying Areas for Water Requirements***
- ***Power Plants and Infrastructure: Vulnerable to severe and irregular Weather Conditions such as Flooding, Tsunami, Hurricanes, Droughts, etc.***
- ***Disaster of Nuclear Accident in Fukushima Power Plants in March 2011***

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Concerns About Conventional Fuels

Solution:

1.) Renewable Resources or Inexhaustible Resources;

2.) Energy Efficiency and Conservation

(Cassedy, 2000)

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Wind Energy
Annual Availability of Wind Energy

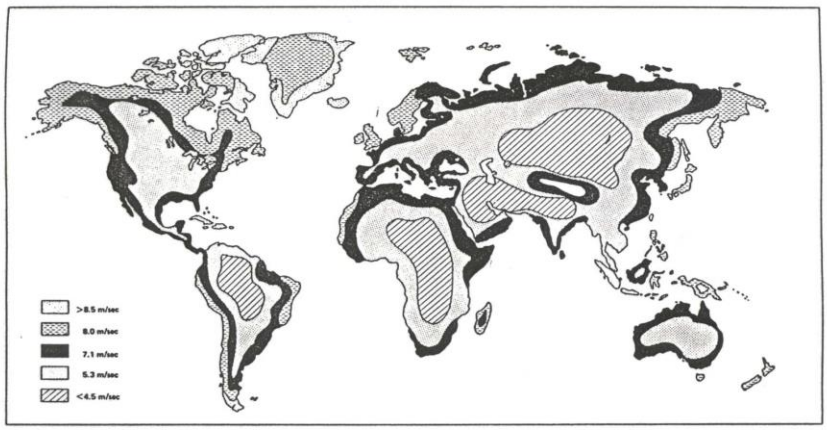

FIGURE 13-5. Annual availability of wind energy. (Reprinted with permission from Charles A. Zraket and Martin M. Scholl, *Solar Energy Systems and Resources*, McLean, Va.: MITRE Corp., 1980, pp. 8–9. Copyright © MITRE Corporation.)

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Solar Energy: Annual Number of Sunshine Hours

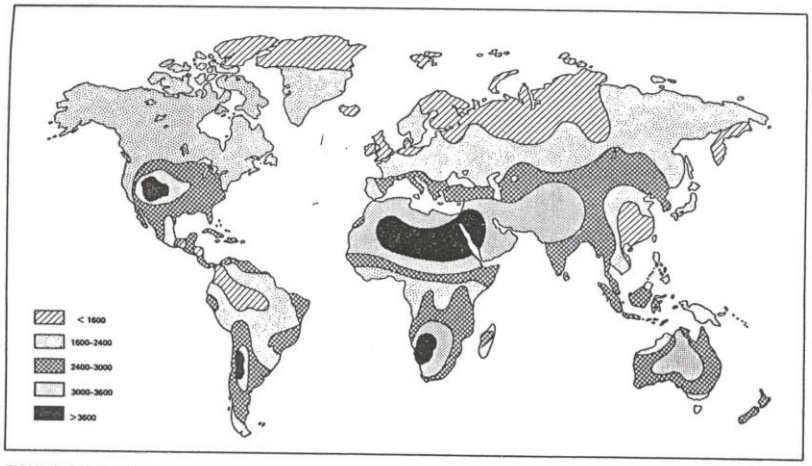

FIGURE 13-1. Annual number of sunshine hours. (Reprinted with permission from Charles A. Zraket and Martin M. Scholl, *Solar Energy Systems and Resources*, McLean, Va.: MITRE Corp., 1980, pp. 6–7. Copyright © MITRE Corporation.)

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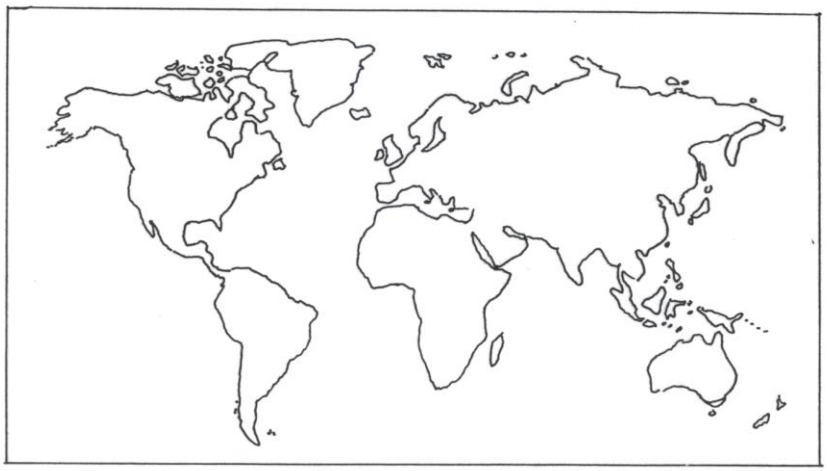
Figure 0



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Going Completely Renewable: Technical Feasibility

Intermittency can be Mitigated and even Eliminated

- ***Interconnecting Dispersed Resources***
- ***Integrating Renewable Systems together***
- ***Utilizing Smart Meters***
- ***Utilizing Batteries in Electric-Powered Vehicles***
- ***Coupling Renewable Systems to Large-Scale Storage Technologies***

(Sovacool et al., 2009)

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Going Completely Renewable: Economic Feasibility

- ***In terms of Marginal Capital Cost, Wind and Biomass are already cheap Systems to build (4^{th} and 5^{th} out of 13 Generation Options)***
- ***Marginal Levelized Cost still favors Renewable Power Sources (6 out of 7 below 7 cents/kWh are Renewable Sources)***
- ***These Prices are still heavily biased against Renewable Resources (no Consideration of Positive and Negative Externalities)***

(Sovacool et al., 2009)

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Going Completely Renewable: Thermodynamic Efficiency

Energy Payback Ratio (EPR): Ratio of Total Energy produced Compared to the Energy needed to Build and Operate

- ***EPRs for Coal, Oil, and Natural Gas were much lower than Renewable Energy Systems (3.35 vs. 34 for Onshore Wind)***
- ***The EPR for Fossil Fuels declines further as these Fuels become depleted and more Energy-Intensive to extract and transport***

(Gagnon in Sovacool et al., 2009)

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All Energy Needs through WWS

Providing all Energy for all Purposes from Wind, Water, and the Sun (WWS)

- ***Needing about: 4 Million 5-MW Wind Turbines, 90,000 300-MW Solar PV plus CSP Power Plants, 1.9 Billion 3 kW Solar PV Rooftop Systems, etc.***
- ***Variability: Gap-filling WWS Resources (such as Hydropower), Smart Demand-Response Management, Interconnection over wide Regions, Energy Storage (V2G), Generation exceeding Peak Power Demand (also providing Power to produce Hydrogen)***
- ***Governments Implement Policies more rapidly than would occur if Development were left mainly to the Private Market***
- ***Fossil-fuel and Nuclear Power Plants and Internal-Combustion-Engine Vehicles can be retired and replaced with WWS by 2050***
- ***The Obstacles to realizing this Transformation are primarily Social and Political, not Technological***

(Delucchi and Jacobson, 2011)

German RE Electricity Production (GWh) and Shares (%): 1990 -2012

Year	Hydro	On-Shore Wind	Off-Shore Wind	Biomass	Solar PV	Geo-thermal	Total Renewable	Total Electricity Generated	RE Share
1990	15,580	71		1,434	1		17,086	551,148	3.1
1995	20,747	1,500		2,013	11		24,271	539,356	4.5
2000	24,867	9,513		4,737	64		39,181	576,191	6.8
2005	19,576	27,229		14,025	1,282	0	62,112	614,972	10.1
2010	20,958	37,619	174	33,866	11,729	28	104,374	610,373	17.1
2011	17,674	48,315	568	37,603	19,340	19	123,519	602,531	20.5
2012	**21,200**	**45,325**	**675**	**40,850**	**28,000**	**25**	**136,075**	**594,216**	**22.9**
%	**3.6**	**7.6**	**0.1**	**6.9**	**4.7**		**22.9**		

Source: Morey & Kirsch, 2014

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Long-Term Energy Efficiency Potential

Viewed as a Short-Term Resource, but this View is now changing

In 2010 the U.S. Economy consumed a Total of 98 Quads, but it would require a Total of only 70 (42%) and 50 Quads (59%) of Energy in 2050 for the Advanced Case and the Phoenix Case, respectively

RMI: Energy Efficiency could bring the Energy Consumption down to 71 Quads by 2050

(Laitner et al, 2012)

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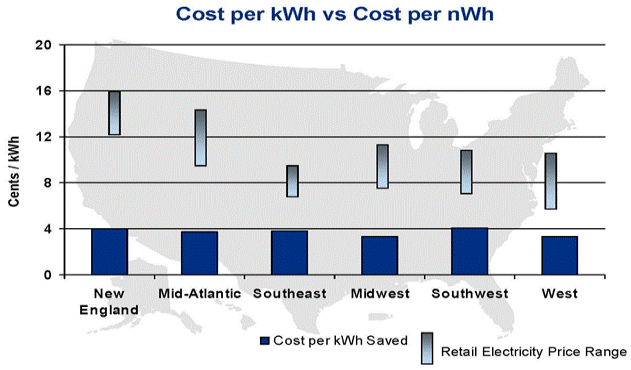
Conservation: Negawatt

The "Negawatt" – **not consuming**

The cost of saving energy is significantly less than electricity rates throughout the U.S.



Source: Erhardt-Martinez & Laitner (2008) *The Size of the U.S. Energy Efficiency Market*. ACEEE.

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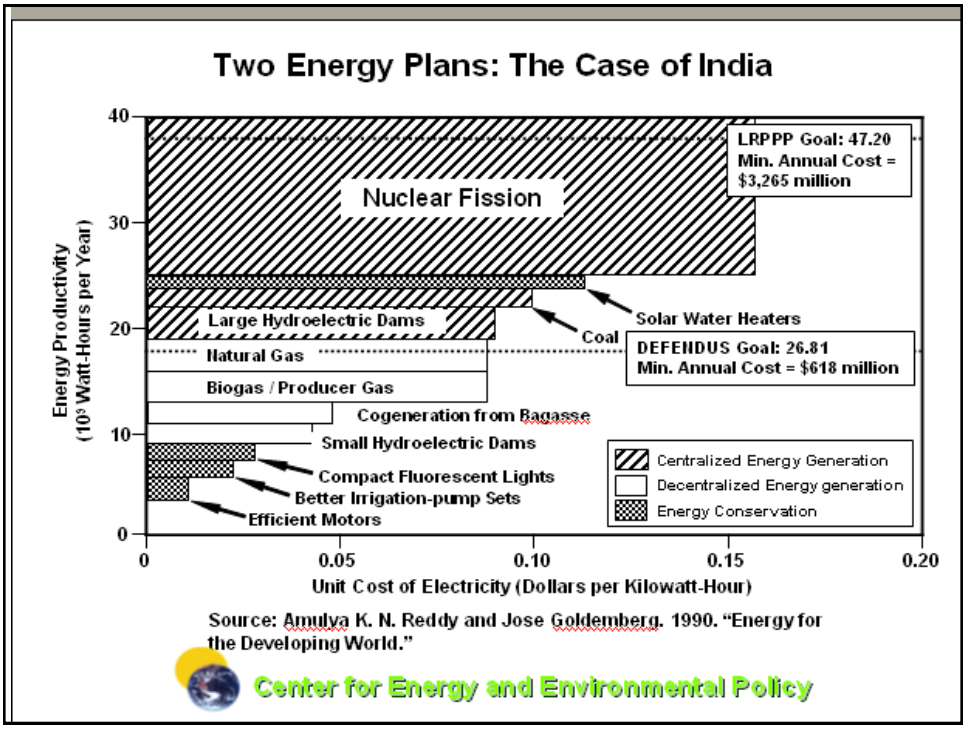

Source: Amulya K. N. Reddy and Jose Goldemberg. 1990. "Energy for the Developing World."

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Energy Decentralization: DG Technologies

Characteristics of the 21st Century Energy Economy may be Decentralization

- ***As with Cellular Phones, Decentralized Energy Technologies could be less expensive Way of providing Energy***
- ***Small-scale, Modular Technologies could be cheaper (Mass Production of a Model T)***
- ***Hydrogen may become the Main Fuel for the 21st Century***
- ***Fuel Cells: nearly as Economical on a Small Scale as on a Large One***
- ***Natural Gas could form a Kind of Bridge to Hydrogen***

(Flavin, 1999)

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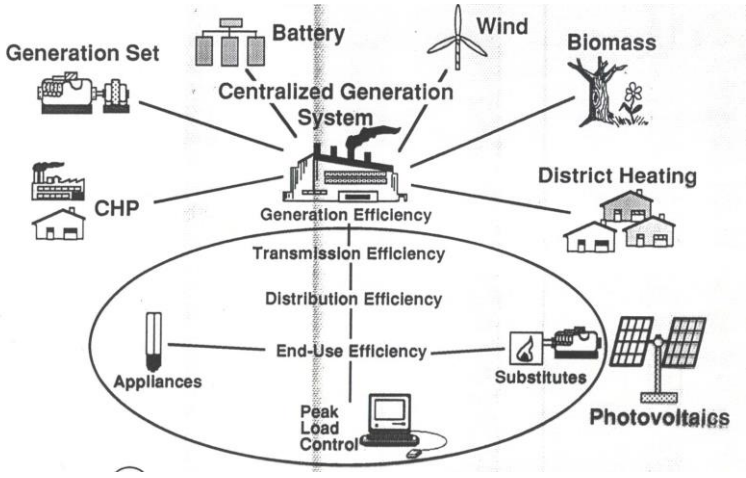
Framework of a Spatially Integrated Electricity Resources Planning



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Decentralized Power: Agile Energy System

Quick, responsive, adaptive, flexible and robust

- ***Distributed Technologies on a small Localized Scale (also Cogeneration and Dispersed Production)***
- ***Greater Diversity of Power Generation with Free Primary Energy with fewer negative E Impacts***
- ***Interconnected as Hybrid Energy System, not a single Technology or several separate Technologies operating in Parallel***
- ***Hybrid Systems: Pumped Storage with Wind; Solar and Biogas Sources of Hydrogen***
- ***Conservation as the first Building Block***

(Clark and Bradshaw, 2004)

Decentralized Combined Heat and Power (DCHP)

- ***A Recent Study by the Carnegie-Mellon shows that a System based on many Decentralized Generation Units located near Users can achieve Desired Reliability with only 5% Reserve Margin, rather than the Standard 15% Margin***
- ***The U.S. will need 137 GW of New Capacity by 2010, costing $84 Billion, plus $220 Billion for Additional T&D. Casten has estimated that Meeting this Demand with DCHP would cost only $168 Billion, with no Additional Needs for T&D***
- ***CHP accounts for over 50% of the Electric Power generated in Denmark; 39% in the Netherlands; 37% in Finland and 31% in Russia; Japan and China are at 18%***

(Ayres, et al. 2007)

A Regional Energy Planning

Integrated Regional Energy Policy and Planning Framework (IREPP)

- ***A clear Target Year with Resource Potential and Objective(s)***
- ***Integrated Resource Planning (optimal Combination of Demand-and Supply-side Options)***
- ***Soft Energy Path (Efficiency, Renewable Sources, and transitional Use of Fossil Fuels)***
- ***Distributed Generation (reduce Needs for costly Peak Power Generation as well as Transmission and Distribution Losses)***
- ***Enhanced Sustainability based on E^4 Balance***
- ***Implementation Feasibility (financial, technological, political, cultural, etc.)***
- ***Monitoring and Evaluation (exploring the Effectiveness of Policies)***

(Wang et al., 2012)

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Jeju Island's Renewable Roadmap

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Evaluation of Jeju Island's Renewable Roadmap

The Jeju Province intends to promote Renewable Energy Applications (a 50 percent Target in 2050) in order to build a Carbon Free Energy System (Plus a 15% Efficiency Improvement)

- ***Wind Power: 15 percent to Total Primary Energy Supply***
- ***Solar Power: 5 percent to Total Primary Energy Supply***
- ***Geothermal Power: 7.5 percent of Total Primary Energy Supply***
- ***Biogas and Biofuels: 5 percent Contribution to Total Primary Energy Supply***
- ***Hydrogen and Fuel Cells: 17.5 percent of Total Primary Energy Supply***

Jeju's overall Target of a 50 percent Contribution in 2050 is ambitious, but not beyond the Range (Hawaii's 40 percent Target in 2030)
(Wang et al., 2012)

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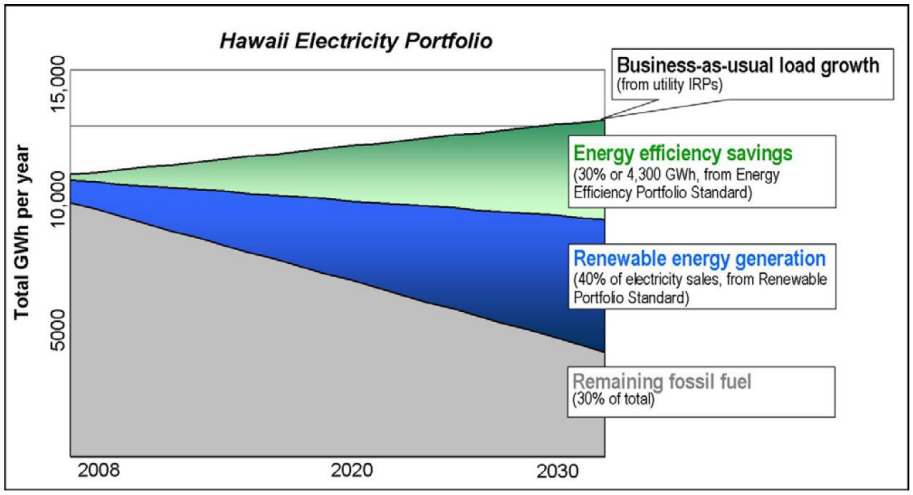

Source: Hawaii Clean Energy Initiative Website
http://www.kauainetwork.org/_library/documents/kesp/technical%20libray/eepspolicybrief31609.pdf

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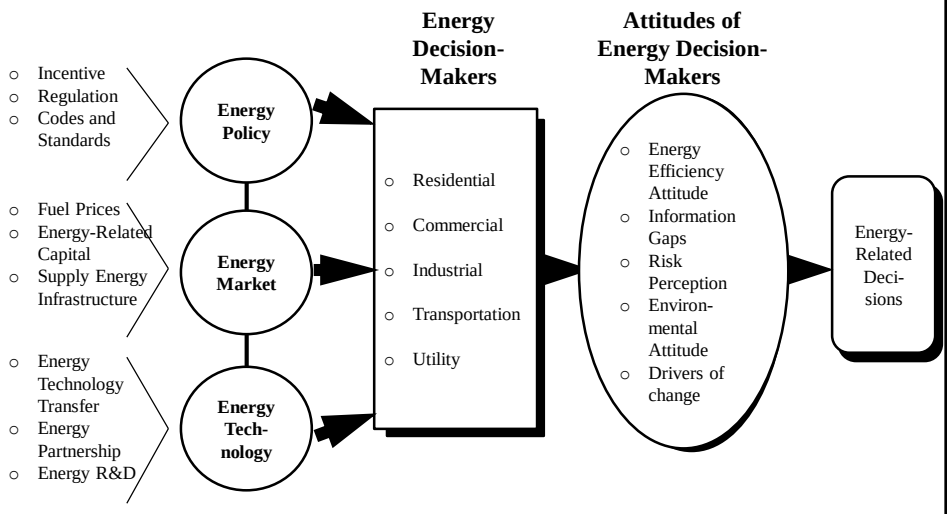
Direct and Internal Factors:
Affecting Energy Decisions of Energy Sectors



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Policy Interventions:
Sustainable Energy Technology

Policies to support Sustainable Energy Technology Innovation include:

- ***Front-End Technology Nurturing: RD&DD***
- ***Back-End Incentives: Tax Credits, Loan Guarantees, Low-Cost Financing, Price Guarantees, Government Procurement, etc.***
- ***Back-End Regulatory and Mandates: Emission Taxes, RPS, Fuel-Economy Standards***

(Weiss and Bonvillian, 2009)

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Strategies for Attitudinal Change

- *Identify Opinion Leaders (Innovators and early Adopters)*
- *Education and Effective Communication*
- *Through Religious Beliefs*
- *Small Group Management of Common Resources*
- *Actions of Peers and Direct Appeals*

(Modified from Gardner, 2001)

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Strategies for Attitudinal Change

- *Identify Opinion Leaders (Innovators and early Adopters)*
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(Modified from Gardner, 2001)

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Community Cooperative: Electricity Generation

- ***Germany:***
- ***Utilities are responsible for purchasing electricity produced by civil renewable cooperatives for 20 years with fixed price***
- ***100 Community Renewable Cooperatives are created each Year***
- ***650 Community Renewable Cooperatives are responsible for 47% of total Renewable Investment in 2012***
- ***Soft Loan (1%) for Renewable Investors by Utility Companies and 1.5% by Germany Reconstruction Bank***
- ***370,000 Renewable Employees, contributing Regional Economic Development***
- ***ROI (5-9%) is higher than Bank Interest Rate (around 1%)***

(Hankook Ilbo, September 29, 2014)

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Delaware's Sustainable Energy Utility (SEU))

- ***SEU is a Third-Party administered Not-for-Profit for delivering Energy Efficiency and Customer-Sited Renewable Energy to End Users***
- ***SEU is the Point-of-Contact for Efficiency and Self-Generation in the Same way that Conventional Utilities are the Point of-Contact for Energy Supply***
- ***SEU includes a Tax-Exempt Bond Program that finances Sustainable Energy Projects with End Users paying back the Costs over time with Savings on their Energy Bills***
- ***SEU's State Building Program is expected to save $27 Million on Energy Bills over 20 Years, while employing 980 Workers to perform the Upgrades***

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Drivers of Change

Playing a Part in producing Rapid Change toward Energy Sustainability

- ***Civil Society:*** *Crucial in Campaign*
- ***NGOs:*** *Framing Issues*
- ***Private Business:*** *Visionary Leadership*
- ***State Power:*** *Political Base*
- ***Scientific Community:*** *Information Base*
- ***Media:*** *Information- Pivotal Position*

(Modified from Gardner, 2001)

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Sustainable Energy Revolution

Change is not easy, but possible

- ***The Abolition of Slavery***
- ***Nonviolent Movement in India***
- ***The End of Apartheid in South Africa***
- ***The Unification of West and East Germany***
- ***Communist Regime Collapse, etc.***

(Modified from Gardner, 2001)

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Thank You

Questions
OR
Comments?