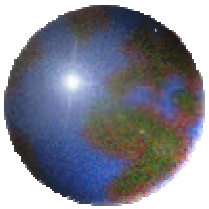


Energy-Smart Community Development

Mayor's Asia-Pacific Environmental Summit

Melbourne, Australia - May 9th, 2006

Presented by

Doug Newman, Global Energy Center at GTI

David Tooze, Office of Sustainable Development - Energy Division

City of Portland Oregon, USA

- Nonprofit R&D Organization Focused On Cleaner Energy & Environmental Technology Deployment

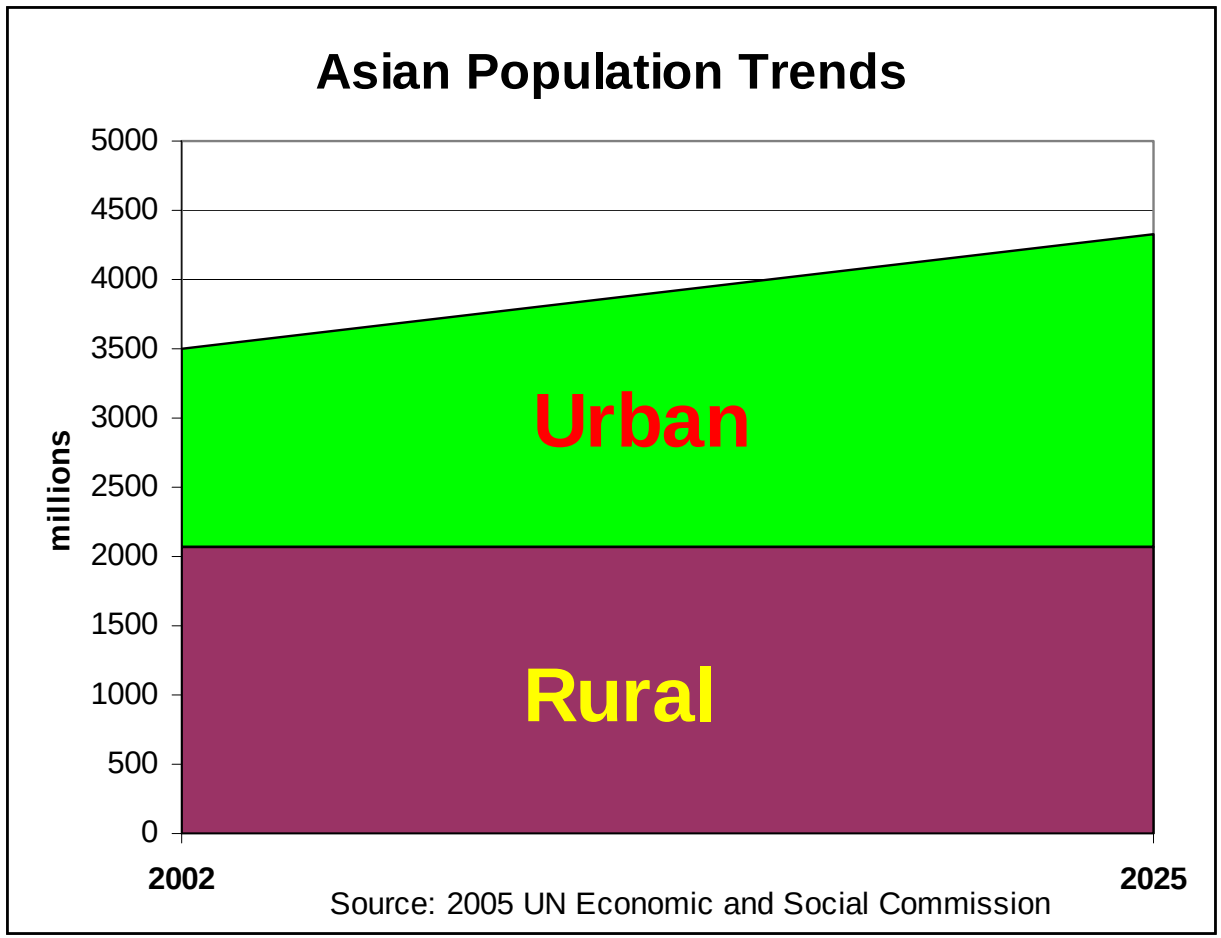
- 300 Scientists, Engineers, Analysts, Planners & Contract Managers With Expertise in:
  - Coal & biomass gasification
  - Hydrogen systems research & development
  - Cleaner industrial & commercial combustion
  - Distributed generation & cogeneration
  - Integrated waste-to-energy systems
  - Environmental sciences & site remediation
  - Sustainable energy planning

Presentation Contents

- Resource Implications of Urbanization
  - Urbanization in the Asia-Pacific region
  - Urban form & resource consumption
  - Economic & human health impacts
- Energy-Smart Community Development
  - Lessons from the global competition on sustainable urban systems design
  - Ecological urban form & function
  - Land use optimization
  - Energy technology integration
  - Community resources management
- Planning Analysis, Design & Implementation
  - Planning analysis & tools
  - Optimized development models
  - Policies, programs & incentives
- Case Study: Portland, Oregon, USA

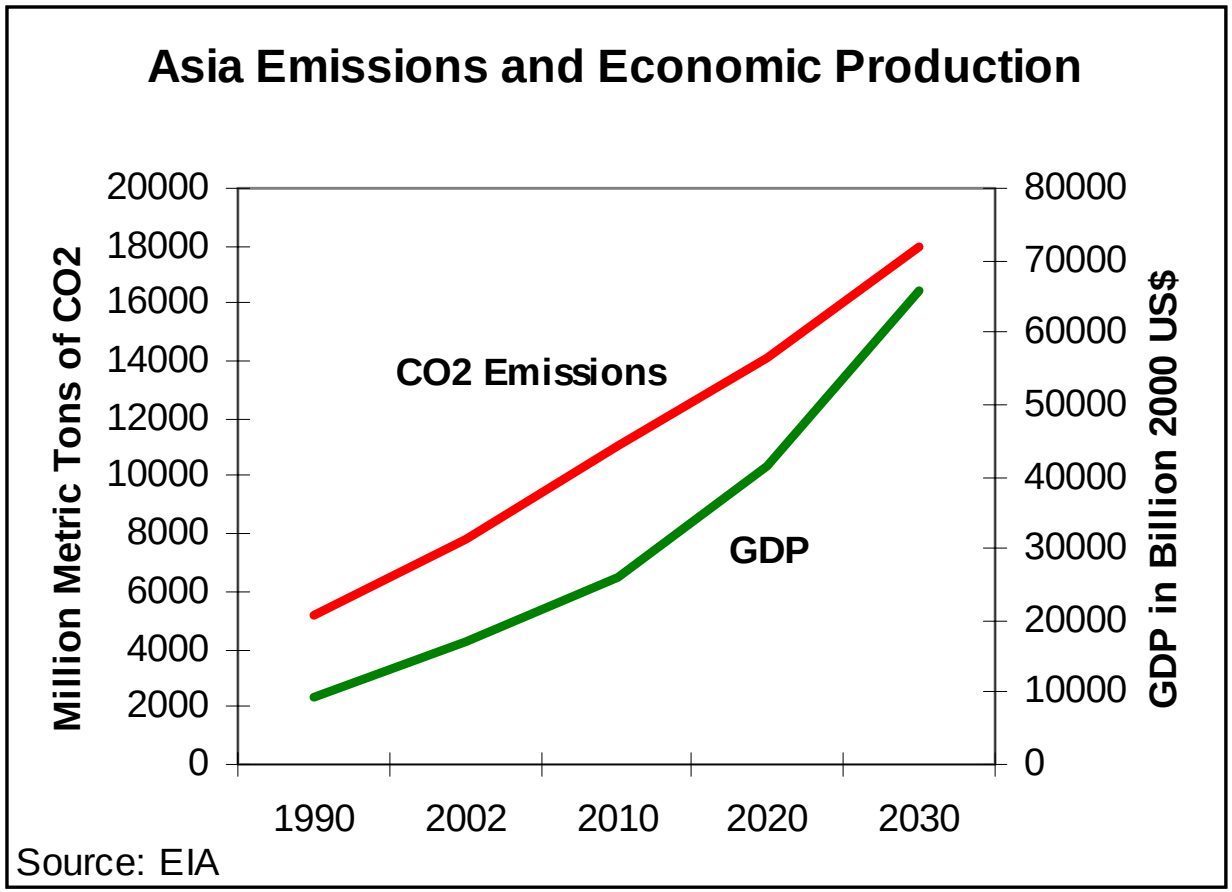
Resource Implications of Urbanization

- The growth in the Asia-Pacific population over the next two decades will be accommodated in urban areas



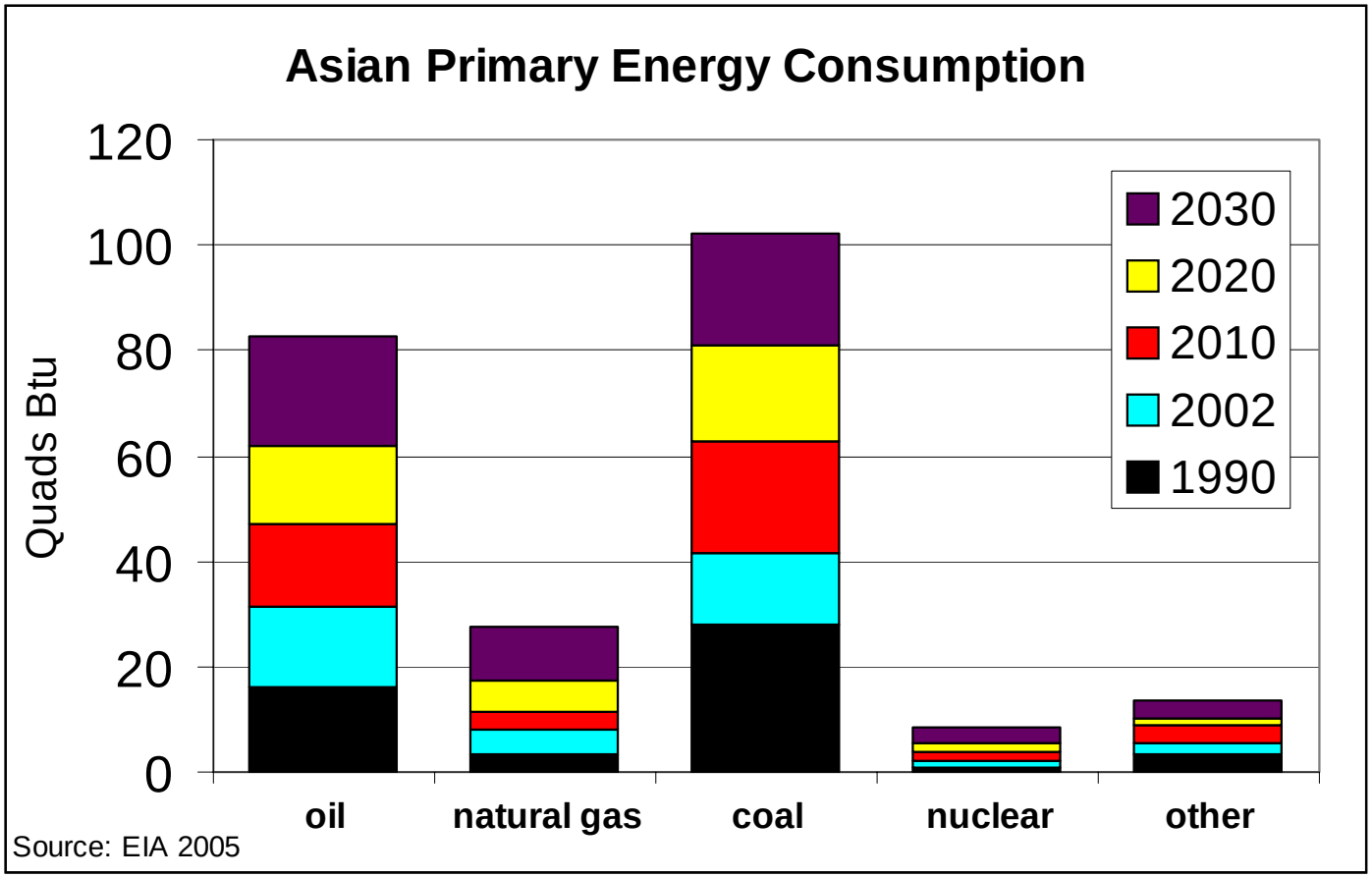
Resource Implications of Urbanization

- Air emissions, and particularly carbon dioxide are expected rise with the growth of GDP in the region



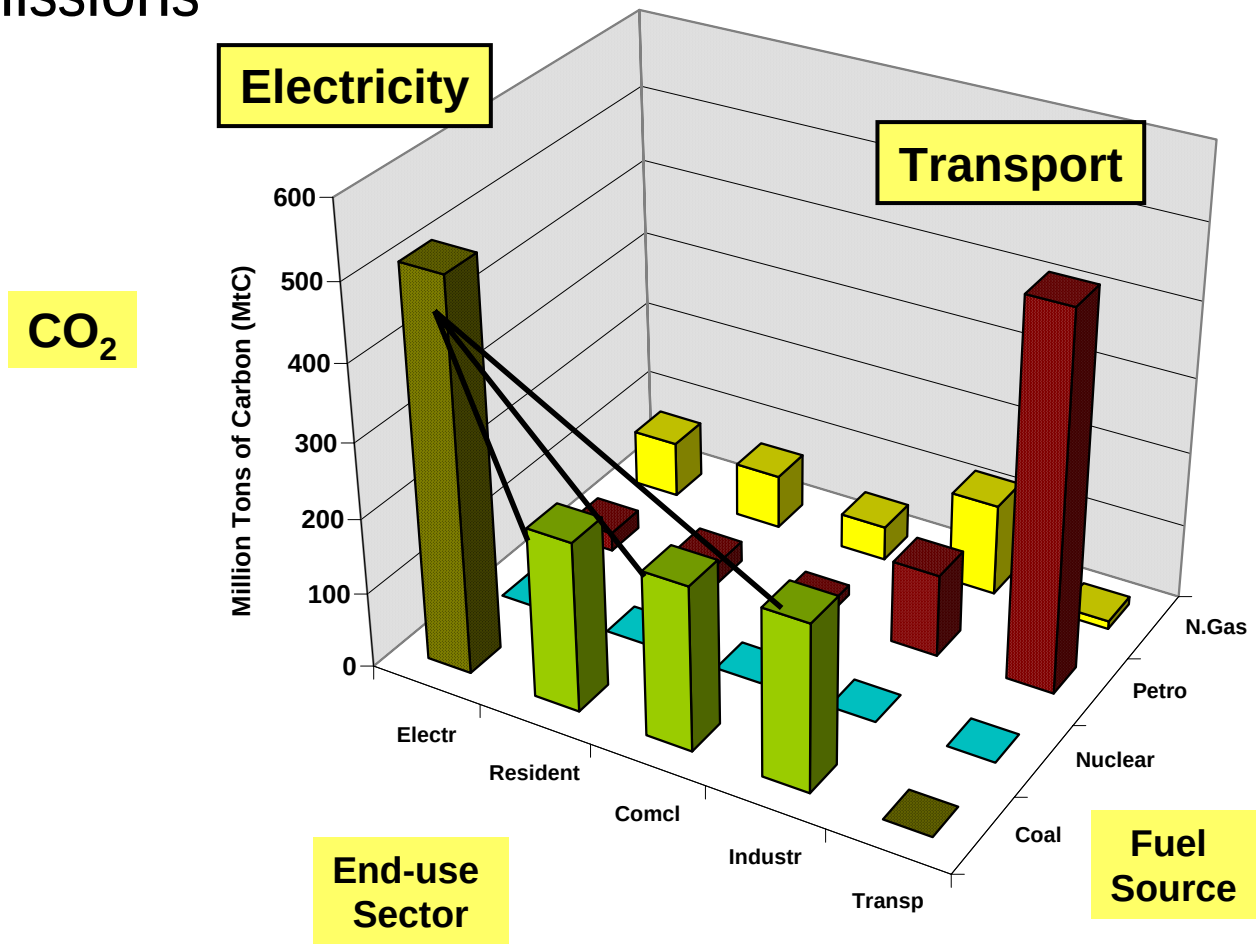
Resource Implications of Urbanization

- Fossil fuels will continue to be the principal source of energy supporting urbanization in the Asia-Pacific region



Resource Implications of Urbanization

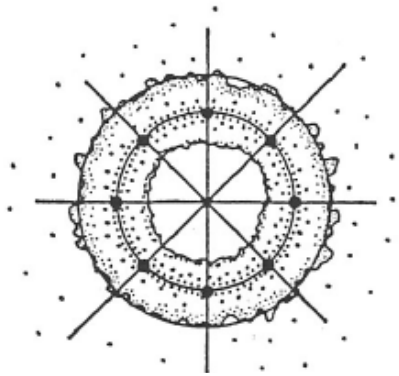
- End-use industrial, commercial & residential electrical & transportation fuel consumption are driving CO_2 emissions



Source: EIA 2005

Resource Implications of Urbanization

- Approximately 70% of urban energy & resource consumption & related air emissions are influenced by land use patterns, transportation & utility infrastructure

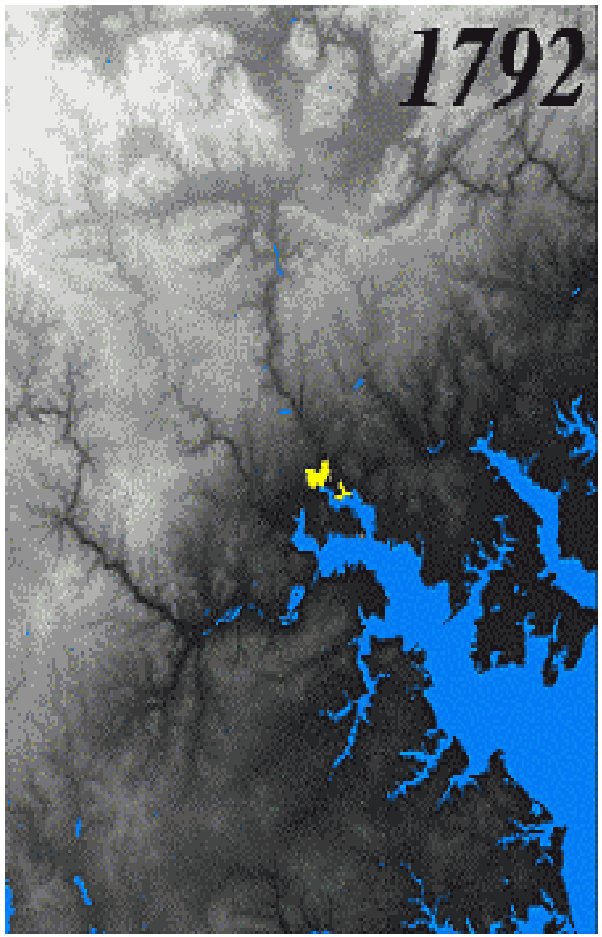


Resources	City Apartments	Village Houses	Ratio
Copper pipe	2,000 ft.	10,000 ft.	5
Arable land	5,000 sq. ft.	200,000 sq. ft.	40
Roadway	1,000 sq. yds.	15,000 sq. yds.	15
Concrete	17,000 cu. yds.	9,000 cu. yds.	1/2
Lumber	25,000 board ft.	1,200,000 board ft.	50
Utility pipe	450 ft.	2,500 ft.	5
Daily postal delivery	12 ft.	3,000 ft.	300
Landscaping water	500 gals/day	35,000 gals/day	70
Heating	5,000 BTU/day	27,000 BTU/day	5
Individual auto	25,000 miles/month	90,000 miles/mo.	4

Source: Phillips & Gnaizda, 1980

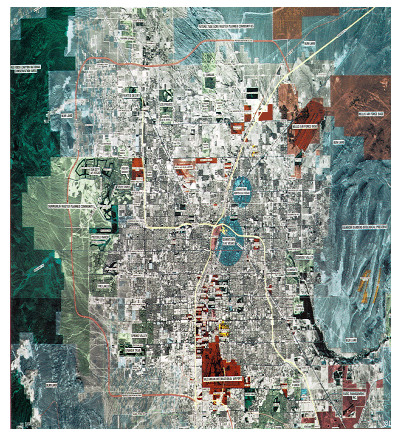
Resource Implications of Urbanization

U.S. Experience



Resulting Urban Form

- Expansive metropolitan regions
  - Concentric growth at the edges
  - Underutilization of the urban core
  - Loss of forests, farms and open lands
- Low-density, resource-intensive suburban & exurban developments
- Many settlements unsupported by indigenous resources
- Spatial separation of functions
- High dependence on automobiles
- Massive traffic congestion
- Significant air, water & solid waste impacts on the local & global environment
- Public Health Impacts



Energy-Smart Community Development

The International Competition for Sustainable Urban Systems Design (ICSUSD)

- Sponsored by the International Gas Union from 2001-2003
- Designs for existing cities that by 2103, would result in the sustainable use of all resources & the practical elimination of global greenhouse gases
- Description of a "*Total Energy System*", in which all aspects of production, consumption & waste disposition are environmentally compatible
- A roadmap defining the institutional, economic, technological & social developments necessary to reach sustainability by 2103

ICSUSD Participants

- Argentina - Buenos Aires
- Canada - Vancouver
- China - Changshu
- Germany - Berlin
- India - Goa
- Japan #1 - Tokyo
- Japan #2 - Mishima
- Russia - Vologda
- United States - San Diego
- Mexico - Tijuana

Energy-Smart Community Development

ICSUSD Jury

- **Dr. Shigeru Ito,** Professor Emeritus, University of Tokyo, Japan
  - **Urban Planning**
- **Dr. Ismail Serageldin**, World Bank & Curator, Alexandria Museum, Egypt
  - **Sustainable Development**
- **Dr. Ernst U. von Weizsacker**, German Parliament, Germany
  - **Global Environment**
- **Dr. Stephen Graham**, Newcastle University, United Kingdom
  - **Information Technology**
- **Mr. Casio Taniguchi**, Mayor Curitiba City, Brazil
  - **City Management**
- **Ms. Haikyung Shin**, Correspondent, Joong-Ang Ilbo, Korea
  - **Culture & Lifestyle**
- **Mr. Gary Neale**, Chairman, President, CEO, Nisource, Inc., United States
  - **Energy**

Design Themes

- **Ecological Urban Form & Function**
  - Design should emulate nature to maximize the benefit of natural systems such as wind & water flows, sunshine, precipitation & the absorbency of land & vegetation
  - Design should preserve & restore the natural environment for the benefit of human, animal & plant inhabitants
  - Design should seek to create a balance & mutually supportive cycle of interaction between the built & the natural environments

- **Land Use Optimization**
  - Design should minimize the consumption of natural & human resources by restructuring & more efficiently utilizing the existing urban footprint (developed areas)
  - Design should seek moderate densification of uses that promote a more “walkable” community & that ensures minimum population densities necessary to support cost-effective urban mass transit

Design Themes

- **Energy Technology Integration**
  - Design should integrate & optimize the efficiency of available advanced energy technologies for all end-uses
  - Design should contemplate the emergence of future technologies & accommodate them where possible
  - Design should seek to reduce <u>embedded</u> energy consumption through material recycling

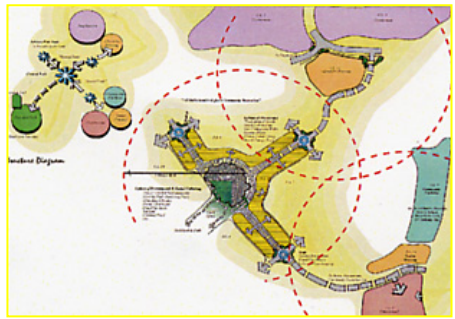
- **Community Resources Management**
  - Design should seek to restore the connection between the consumer & the resource
  - Design should engage the individual & the neighborhood in as many aspects of resources management as possible

Design Themes

- Summary Messages:

1. First: Design communities so they require less energy

2. Second: Maximize efficiency & minimize environmental impacts whenever & wherever energy is used!



Energy-Smart Community Development

Development Tactics

- Ecologic Urban Form & Function
  - Urban heat island reduction
  - Urban surface water control
  - Green structures & processes

- Energy Technology Integration
  - Net-zero building design
  - DG & CCHP energy technologies
  - District energy systems

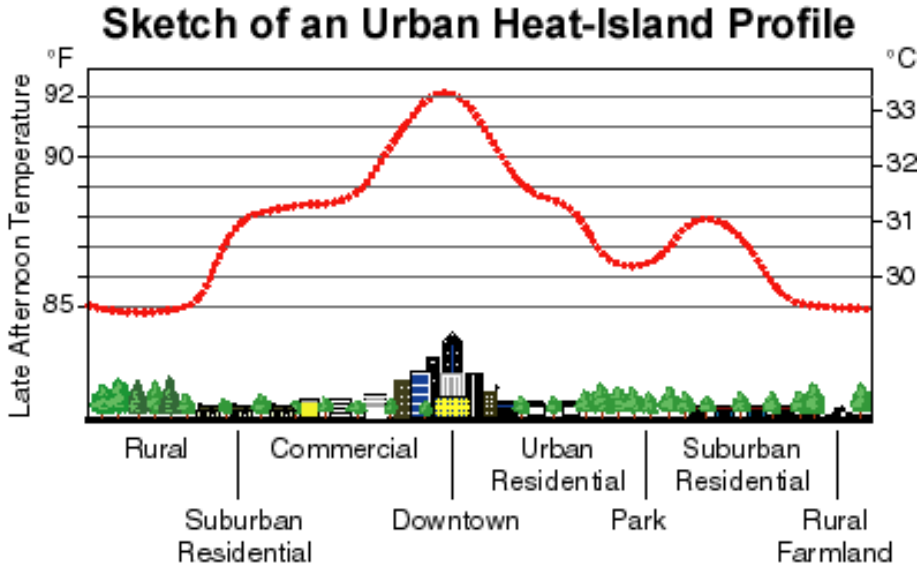
- Land Use Optimization
  - Utilization of the existing footprint
  - Co-location of compatible uses
  - Transit-oriented development

- Community Resources Mngmt.
  - Waste-energy systems
  - Neighborhood centers
  - Smart micro-grids

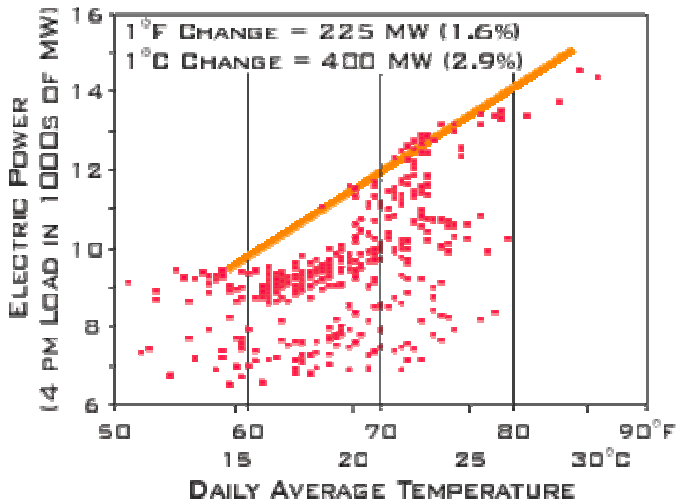
Energy-Smart Community Development

Form & Function: Urban Heat Island Reduction

- Elevated air temperatures in urban areas due to the mass of absorptive building & paving materials
- Drives peak-energy demand higher & significantly increases the incidence of urban smog
- Principal mitigation measures
  - **Reflective Roofing & Surfaces**
  - **Shade Trees**
- Energy savings & additional benefits are substantial

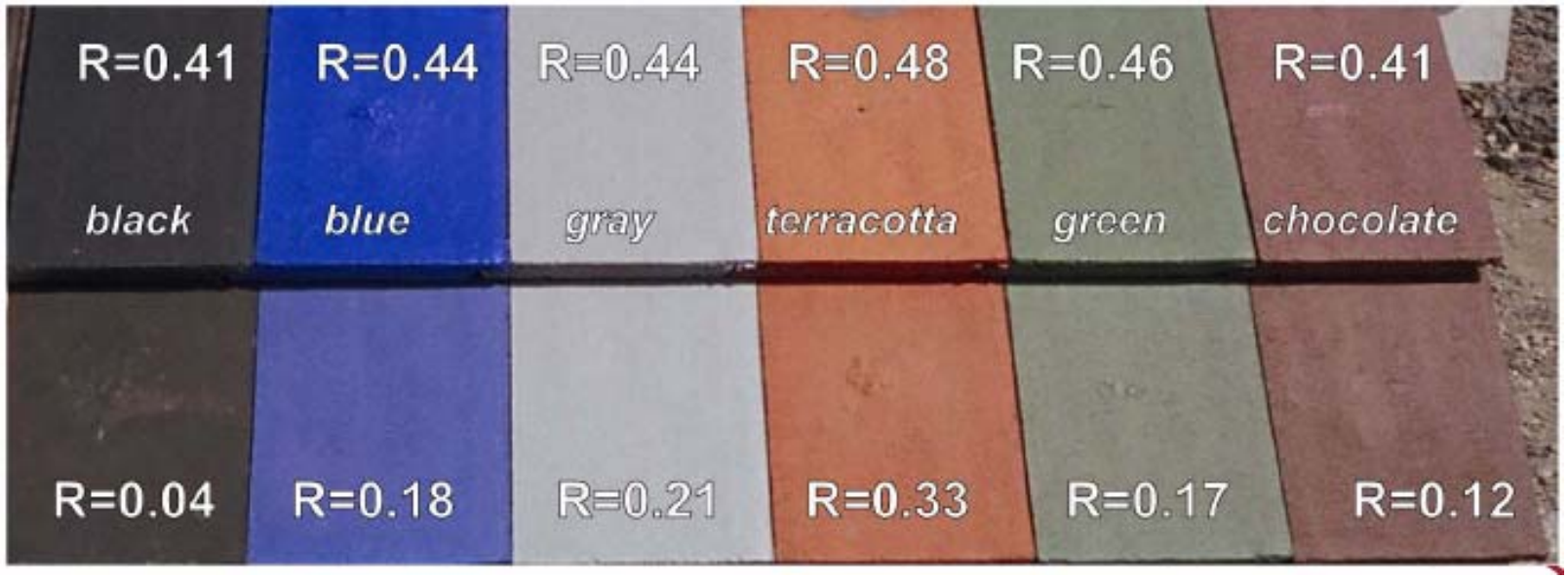


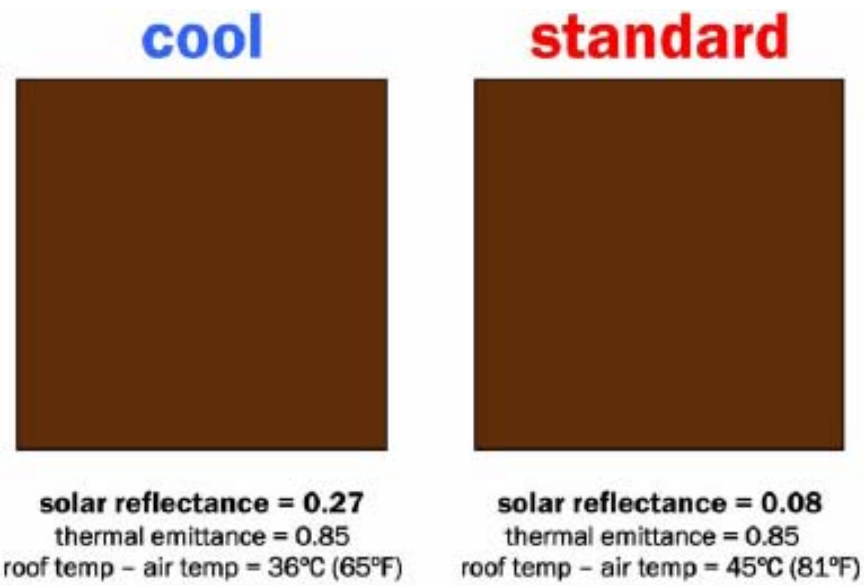
Source: Heat Island Group, LBNL, http://EETD.LBL.gov/HeatIsland

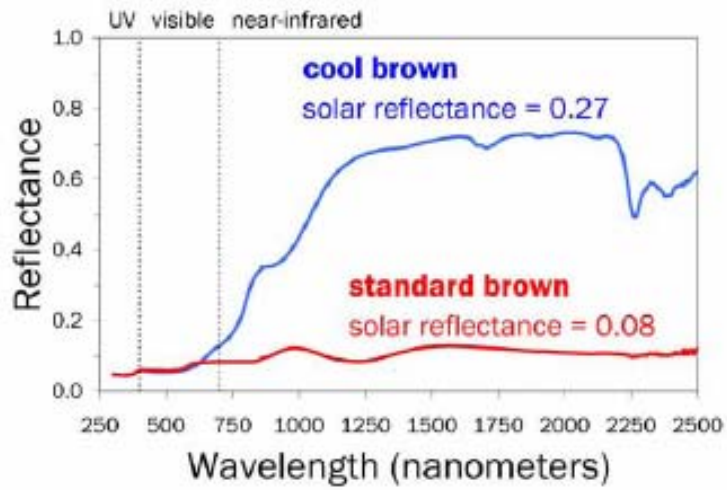


Energy-Smart Community Development

Form & Function: Urban Heat Island Reduction







Energy-Smart Community Development

Form & Function: Urban Heat Island Reduction

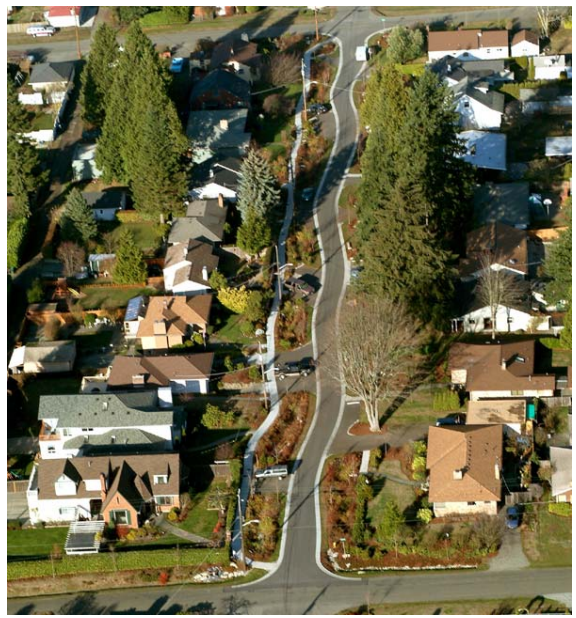
- **Measured Cooling Savings**
  (depending on local climate)
  - **Roofs**
    - Homes - 20% - 80%
    - Commercial buildings - 10%-20%
  - **Trees**
    - Homes - 30%
    - Commercial buildings - 45%
- Potential Savings for Los Angles
  - Direct - $100 Million/year
  - Indirect - $70 Million/year
- Potential U.S. National Savings
  - $5 Billion/year

- **Additional Benefits**
  - Cool/Reflective Surfaces
    - Increased durability
    - Increased roadway visibility
  - Shading of buildings
    - Evaporative cooling
    - Wind shielding
    - Smog reduction
    - PM10 deposition
    - Dry deposition
    - Direct carbon sequestration

Energy-Smart Community Development

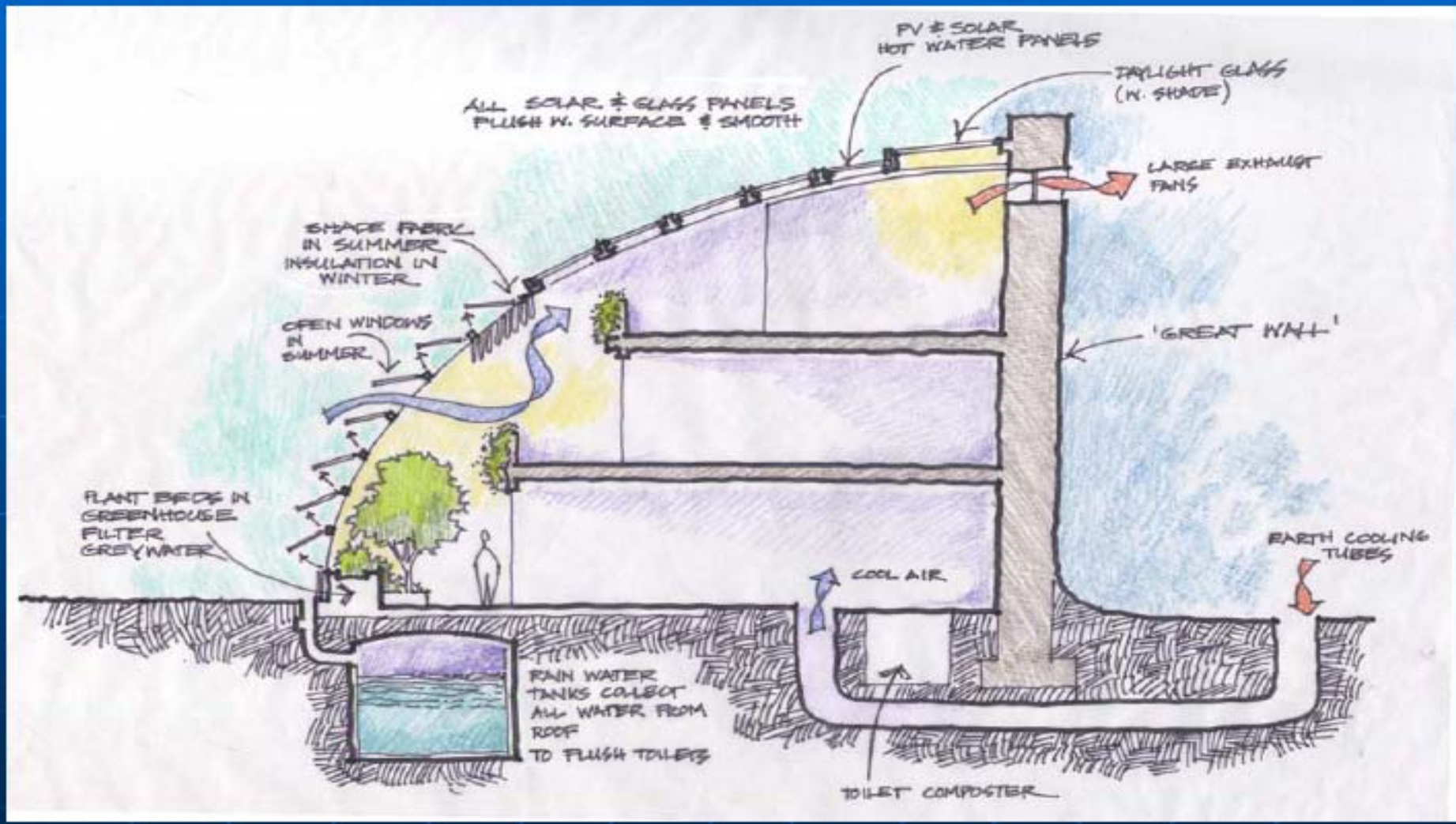
Form & Function: Urban Surface Water Control

- Urban stormwater runoff requires huge amounts of energy to manage
- Stormwater runoff mitigation features & strategies can significantly reduce energy consumption
- These include:
  - Neighborhood stormwater drainage systems & retention ponds
    - bio-swales, cisterns & dry wells
  - Increased use of porous paving
  - Green roofs & other building & landscape features that reduce surface runoff



Energy-Smart Community Development

Form & Function: Green Structures & Processes



Energy-Smart Community Development

Form & Function: Green Structures & Processes

Technologies

- Ground water cooling
- Desiccant dehumidification
- Day light tubes for North room day lighting
- High efficiency lighting
- Natural Air Cleaning, NASA Space Station Tech.
- HEPA and UV air filtration
- Automated controls- lighting, HVAC
- Rain water collection
- Water filtration and purification
- Non Toxic paint
- Non toxic materials
- Advanced shade system
- Electro Chromic Glass
- High Efficiency fans with variable speed drives

Energy-Smart Community Development

Form & Function: Green Structures & Processes

In Vancouver, British Columbia, a 2787 sq. meter office complex, utilizes composting toilets and urinals for human waste disposal. The new building, which houses The Institute of Asian Research, is not connected to the city's sewer system. As well, a subsurface, grey water recycling system with phragmite (tall grasses) plant varieties, cleanses the grey water which is then used for on-site irrigation.

March 30, 2006

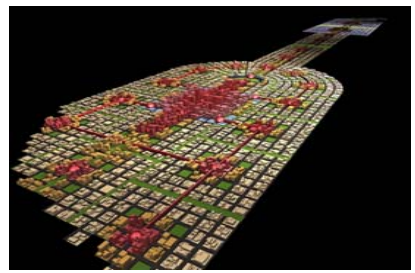
Developed under the
US/China Cooperation on the Green Olympics 2008

Energy-Smart Community Development

Land Use Optimization: Utilize the Existing Footprint

- Typical urban development patterns are characterized by concentric growth at the boundary edge of communities

- Economic enterprises, employment & recreational centers follow peripheral population growth & leave the original urban core to decay

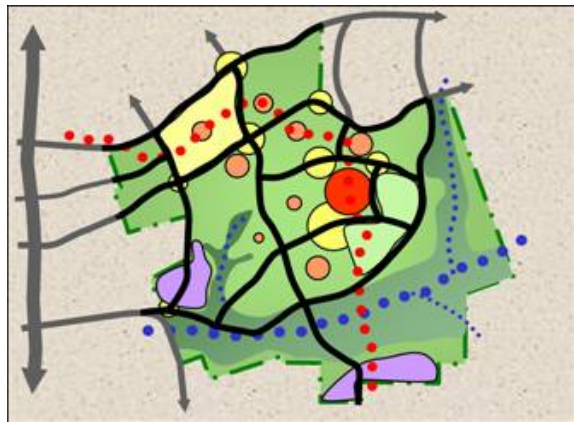


- Energy-Smart development redirects new growth to existing areas of settlement utilizing:
  - The existing utility infrastructure
  - Brownfields & greyfields
  - Adaptive reuse of building stock
  - Increased densification & infill development

Energy-Smart Community Development

Land Use Optimization: Co-Location of Uses

- Separation of residential, commercial, institutional, industrial & civic land uses consumes more:
  - Electrical power & thermal energy
  - Petroleum fuels
  - Land & water
- Produces more:
  - Traffic congestion
  - Air pollution
  - Solid waste
  - Water quality degradation
- Co-location of compatible uses reduces vehicle miles traveled (VMT) & creates ideal conditions for the use of advanced energy-efficient technologies!

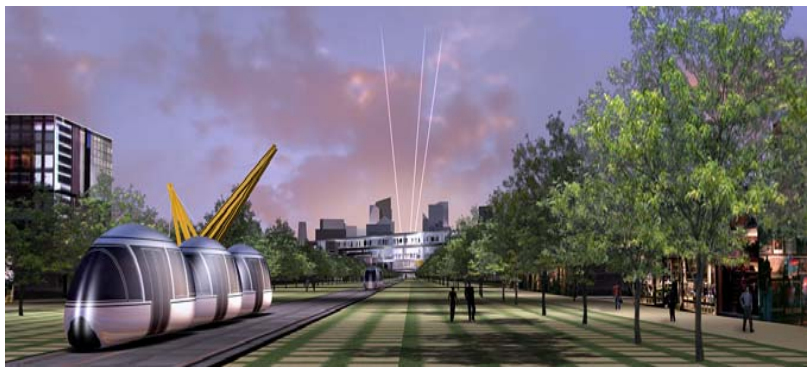


Energy-Smart Community Development

Land Use Optimization: Transit-Oriented Development

- Mixed-use development within close proximity to urban mass transit systems
  - Immediately adjacent
  - Integrated into the structures

- All residential development with ¼ mile of a transit station
  - creating a walkable community & thereby reducing VMT



- Alternatively fueled fleets
- Cascading network of transit lines enabling convenient & efficient mobility locally & within the region
- Development that deemphasizes use of private automobiles

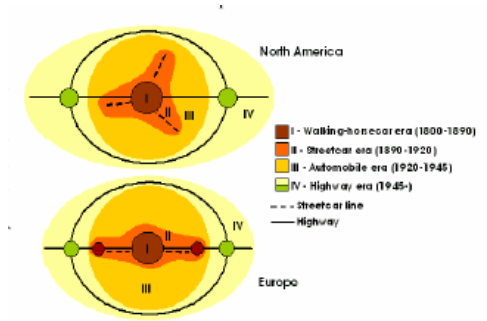
Energy-Smart Community Development

Miashima Challenge

- Environmentally insensitive development practices & uncontrolled/unregulated growth that consumes prime agricultural, forests & wetlands, stresses natural resources & threatens biodiversity

Design Solutions

- Urban containment or growth boundaries

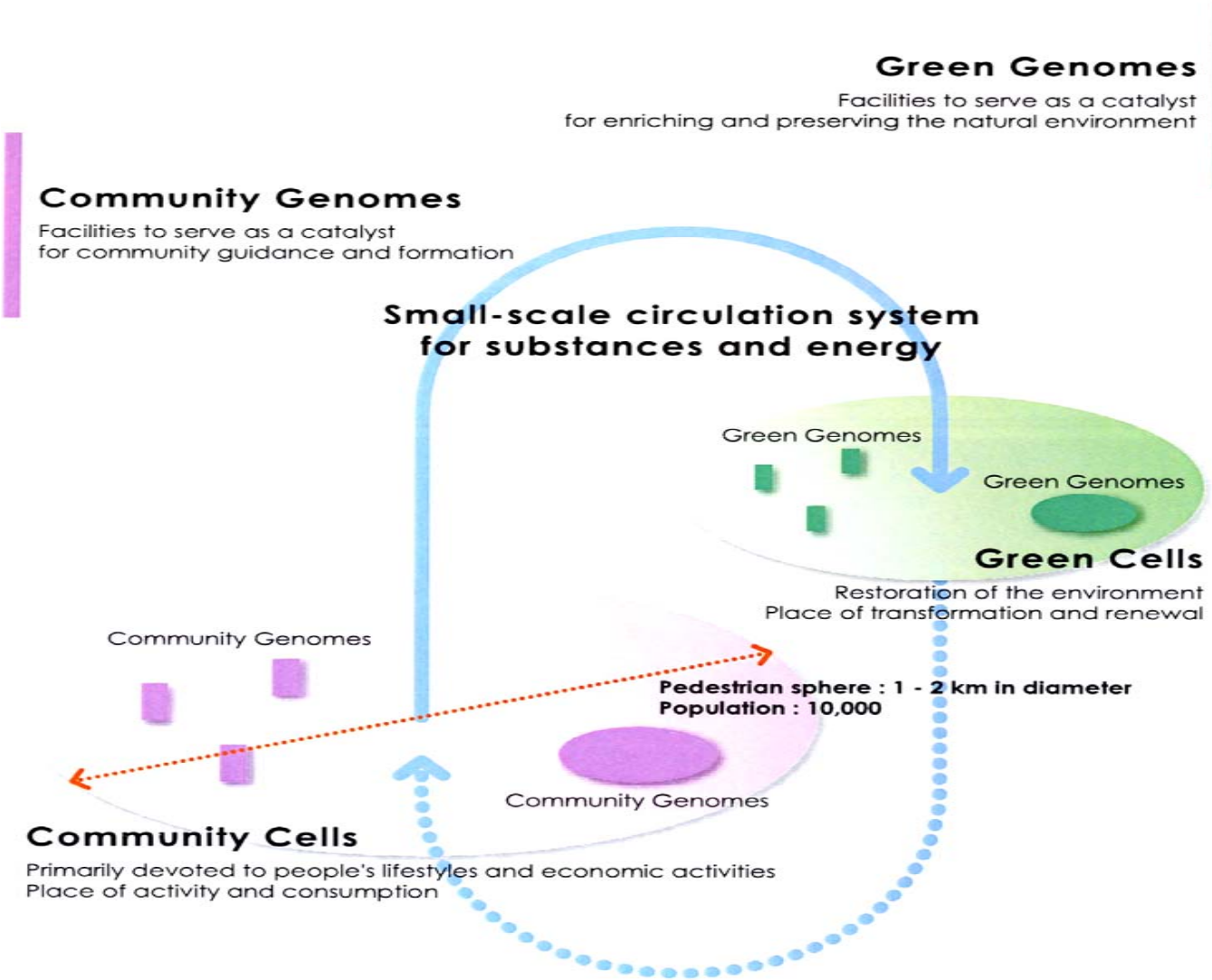


- Mixed-use, transit oriented development & optimization of existing urban footprint

- Concentration of growth in self-sufficient urban cells/clusters or villages

Energy-Smart Community Development

Japanese Team – Cellular Dynamic



Cell operation

These genomes guide the formation and operation of Green Cell while they organize the agricultural and factory operations that are the mainstay of the economy.

Utility

These factory type facilities support small-scale circulation between cells. They include waste water treatment plants and power generation facilities.

Environmental preservation and restoration

These genomes play a role in preserving and restoring the natural environment while they plant trees and beautify the environment by volunteer activities.

Recreation

These facilities are provided for outdoor recreation. They include campgrounds and sports facilities.

Diversity promotion

These genomes guide to bring out the unique attributes of each cell, creating diversity in the city. They include existing and cultural facilities and festivals.

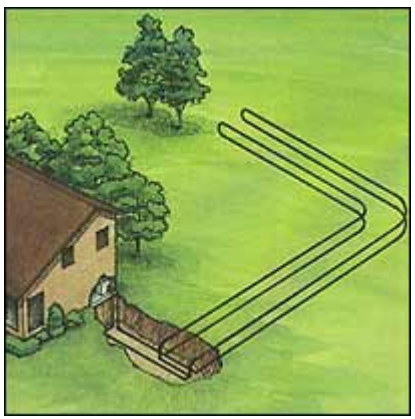
Energy-Smart Community Development

Energy Technology Integration: Net-Zero Buildings

- The Concept
  - Buildings that produce as much or more energy than they consume in one year!

- Utilizes green structure & process features

- Incorporates hyper efficient building materials
  - glazing, insulation, surfaces, roofing, water systems



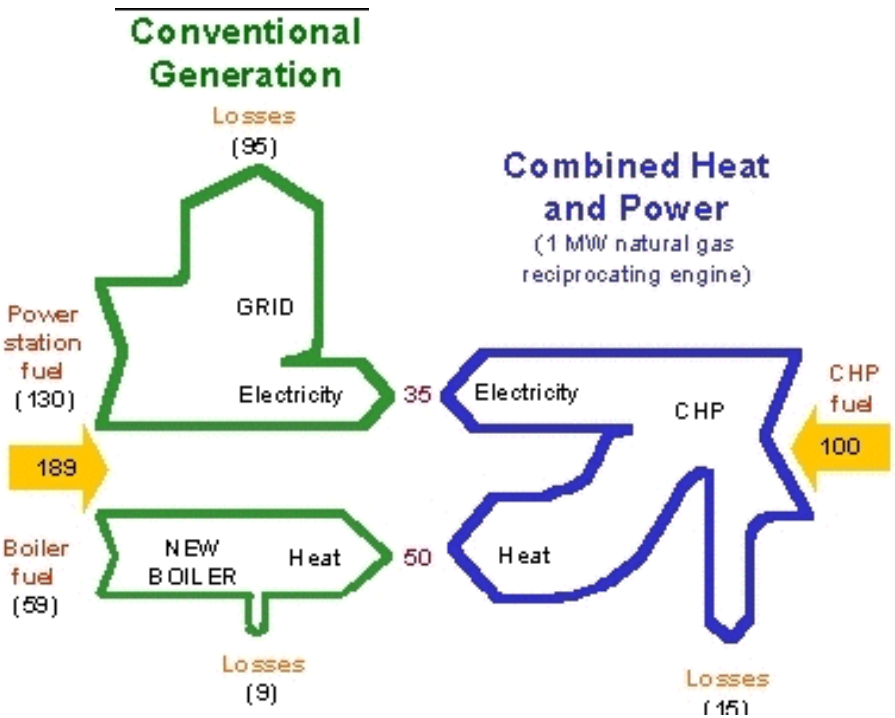
- Utilizes a variety of renewable energy technologies

- Feeds excess energy back to the grid or other local users

Energy-Smart Community Development

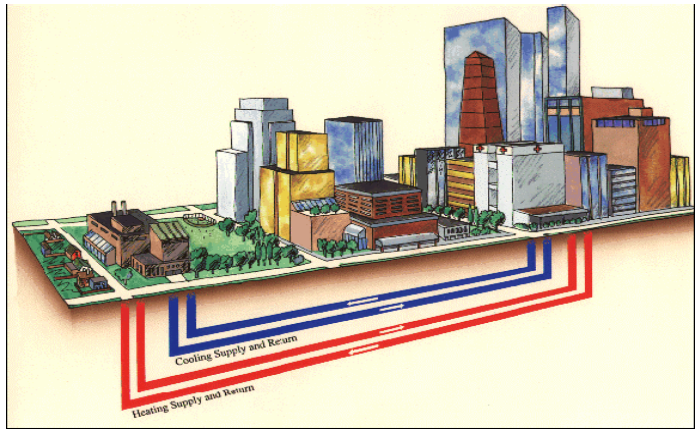
Energy Technology Integration: DG & CCHP

- Energy-smart urban design can create ideal spatial conditions (specifically via co-location of uses) that maximize economical use of distributed generation (DG) & combined cooling, heat & power (CCHP) systems



Energy-Smart Community Development

Energy Technology Integration: District Energy



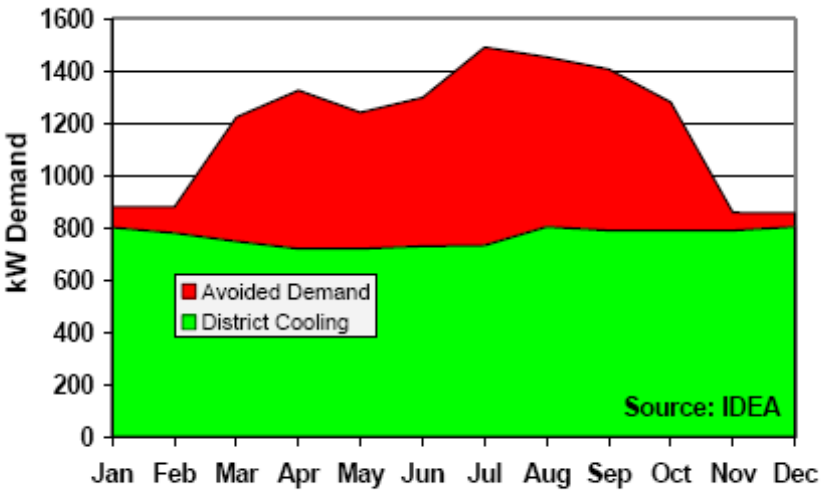


Figure 6: Cuyahoga Savings Center Electricity Demand

- District power & thermal energy systems for space conditioning & commercial process steam
- Benefits
  - 70% energy efficient
  - Cost savings to individual developers
  - Lower costs for “client” building owners
  - More secure & reliable energy supply
  - Enables more profitable use of commercial floor space in client buildings
  - Environmentally friendly
    - minimizing NOx & SOx via natural gas
    - chillers using non-ozone depleting refrigerants
  - More aesthetic

Energy-Smart Community Development

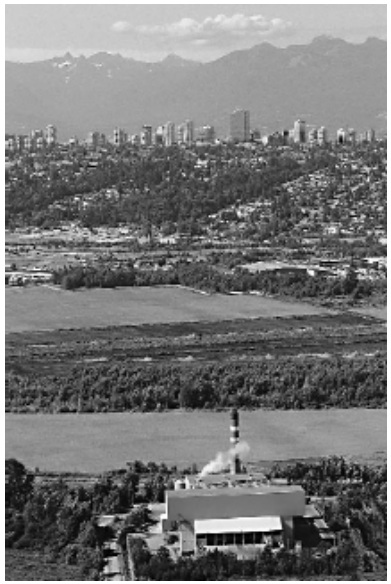
Energy Technology Integration: District Energy

Kuala Lumpur District Power & Cooling Systems

- 30,000 ton chilled water plant, powered by natural gas-driven cogeneration equipment in concert with steam turbine driven chillers & electric chillers
- The District Cooling Centers operate using the R-134A ozone-friendly refrigerant, replacing the ozone depleting chloro-fluorocarbons (CFC)
- Integrated systems in use at the KL City Center, Airport & on the national government campus in Putrajaya

Energy-Smart Community Development

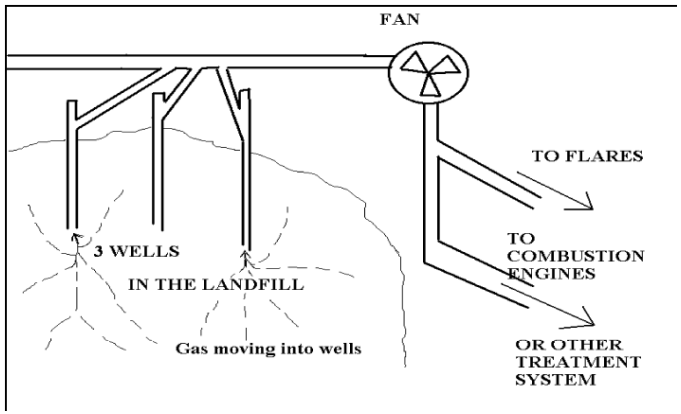
Community Resources Management: Waste Energy
Solid Waste Power Generation



- Waste is sorted for recyclable & hazardous materials & the remainder is burned to drive a steam turbine for electricity or to deliver steam to nearby industrial users
- Reduces solid waste mass by 90% & ash can be used in building products

Energy-Smart Community Development

Energy Technology Integration: Waste Energy
Solid Waste/Landfill Bio-Gas



- Relatively small quantities of LFG (methane & carbon dioxide) can be used to produce clean, efficient energy
- Methane is harvested through wells & blown to a gas processing unit that cleans the fuel for onsite electric power & thermal production or for pipeline distribution
- Reciprocating engines or micro-turbines burn the LFG to produce electricity & thermal energy for industrial uses

PHOTO: CAPSTONE

Energy-Smart Community Development

Community Resources Management: Waste Energy
Municipal Wastewater Bio-Gas

- Converting sanitary water flows into electricity & thermal energy
- Anaerobic digestion - bacteria working in the absence of air convert organic matter into methane and carbon dioxide

- Two-stage digestion processes maximizes the productivity of bacteria enabling them to deliver biogas with methane values at 65-75%
- Australian MWWTP waste energy systems

Power Plant	Capacity (MW)
Brisbane City Council:	
Luggage Point Treatment Works	3.2
Melbourne Water:	
Western Treatment Plant	1.3
South Australian Water Corporation:	
Bolivar Treatment Plant	2.0
Glenelg Treatment Plant	0.6
Port Adelaide Treatment Plant	0.35
TOTAL	7.45

Energy-Smart Community Development

Community Resources Management: Neighborhood Centers

- A means of restoring the connection between the consumer & the resources

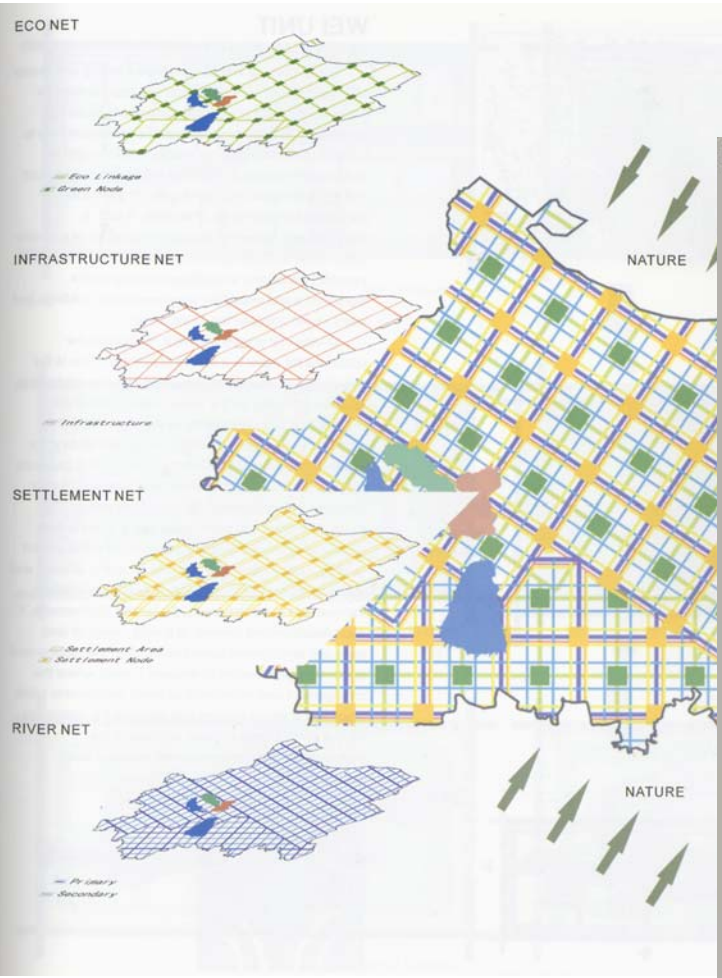
- Facilities located within neighborhoods that are used to reclaim & recycle grey water & solid waste & to generate & distribute power & thermal energy to local residents

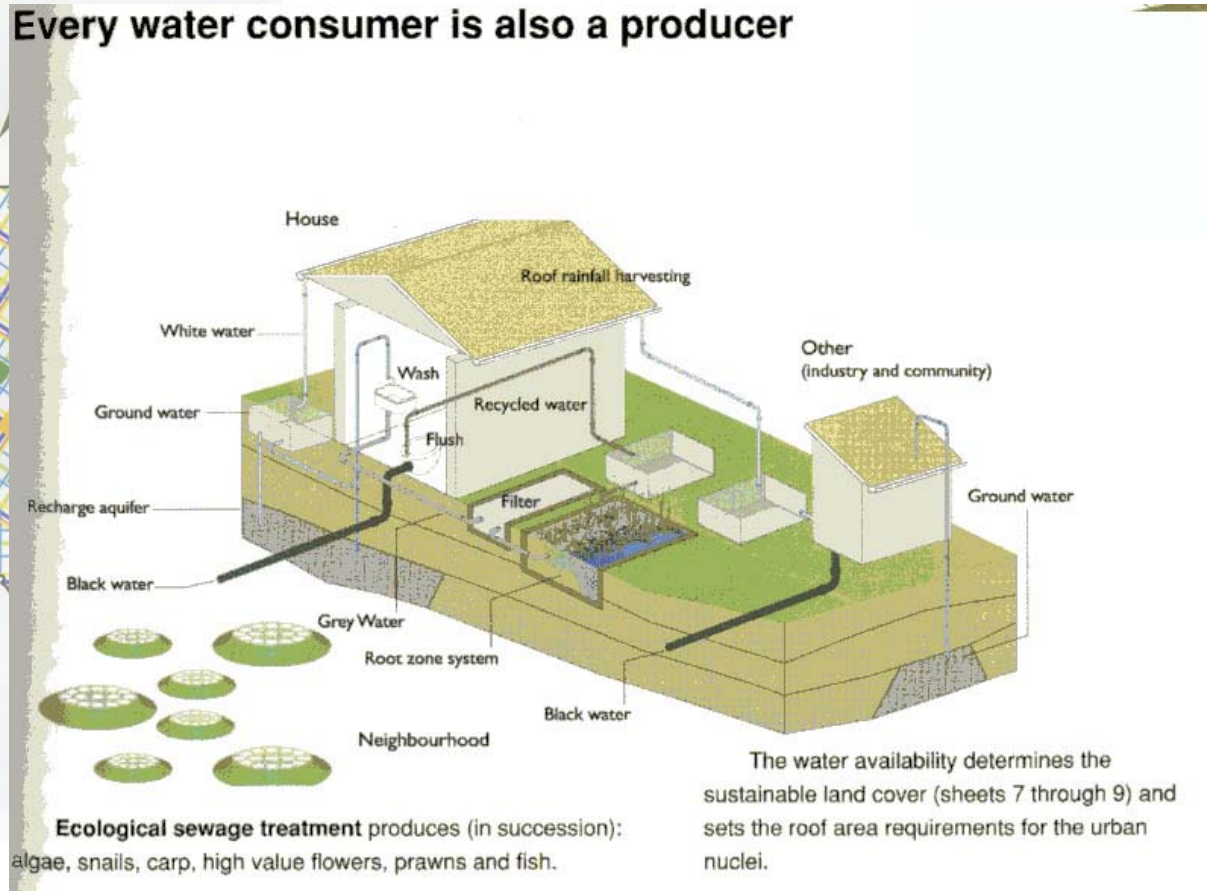
- Termed “Resource Management Centers” or RMCs, these centers can capitalize on the availability & movement toward decentralized power technologies & micro-grids for local energy reliability & security

- See GTI’s 15-minute DVD entitled: “*Energizing Sustainable Cities*” for a computer animation that shows how these centers will operate in the future!

Energy-Smart Community Development

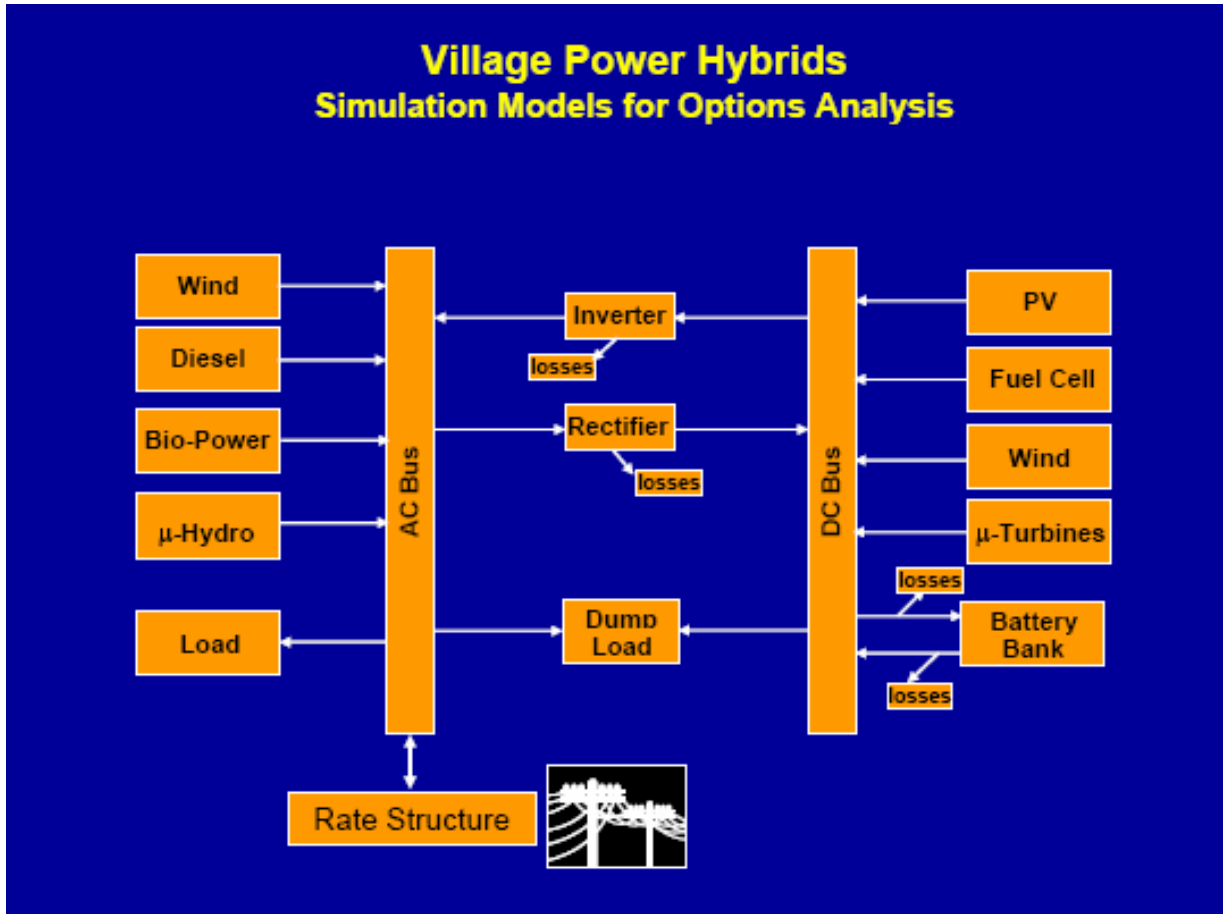
Community Resources Management: Local Recycling
Chinese Team - WEI System





Energy-Smart Community Development

Community Resources Management: Smart Micro-Grids

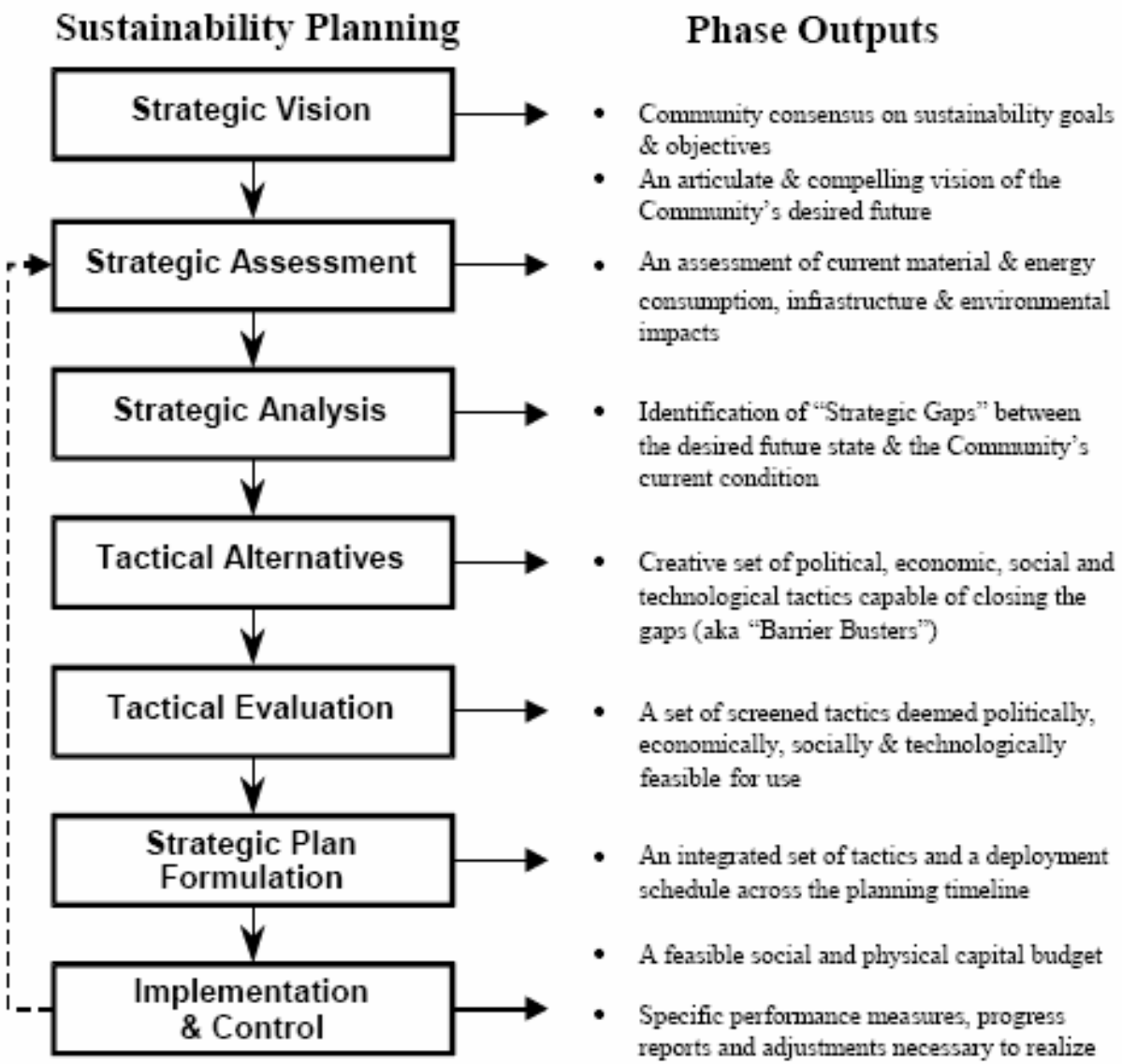


Source: Roger Taylor

- Multiple sources of renewable energy & advanced generation
- Intelligent, interacting local micro-grids reinforcing the community
- Consumers utilizing demand response control technologies

Planning Analysis, Tools & Implementation

A Planning Process



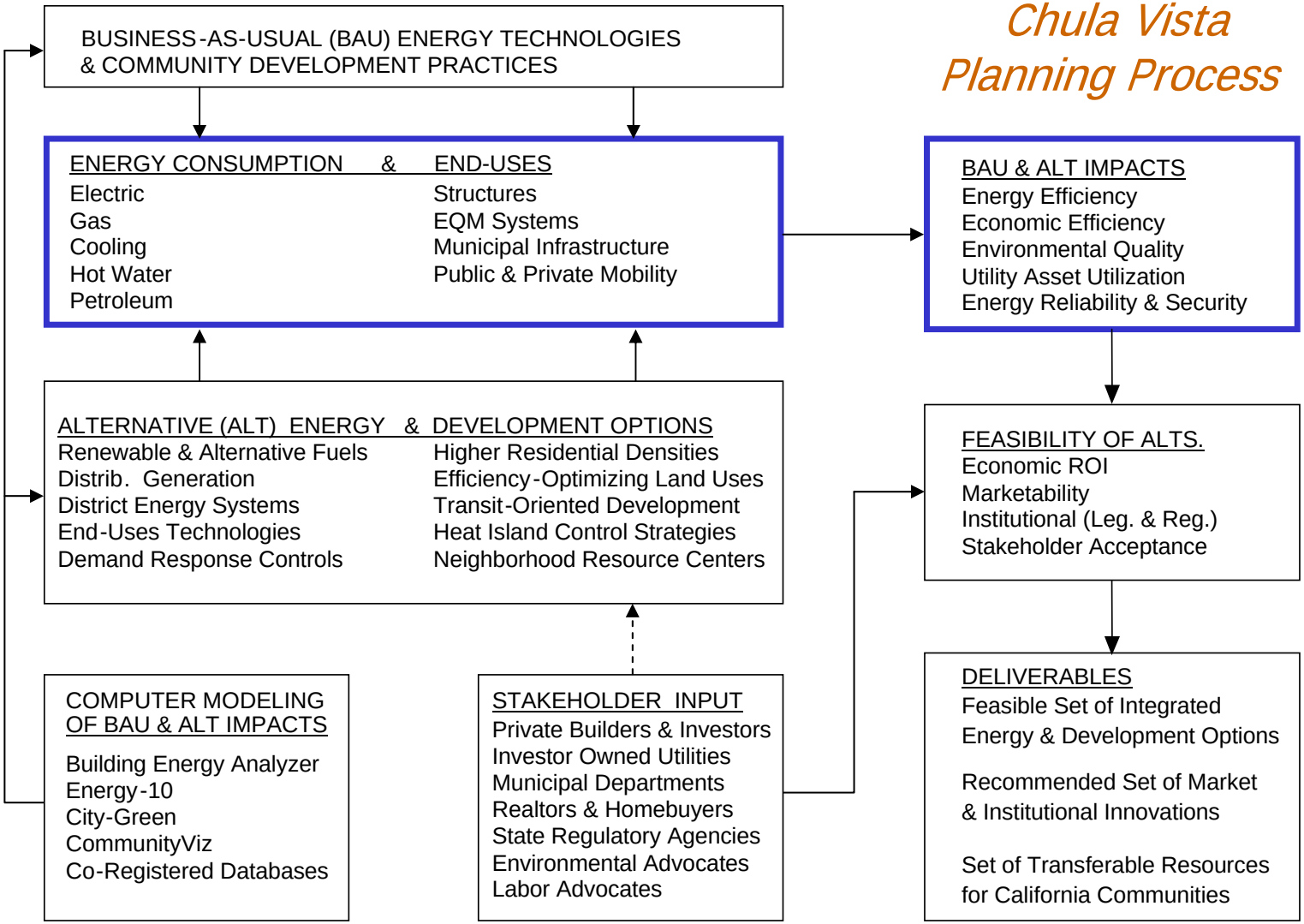
Planning Analysis, Tools & Implementation

Optimized Development Models – Chula Vista, California

Chula Vista Research & Planning Project
Funded by the U.S. Department of Energy & the California Energy Commission

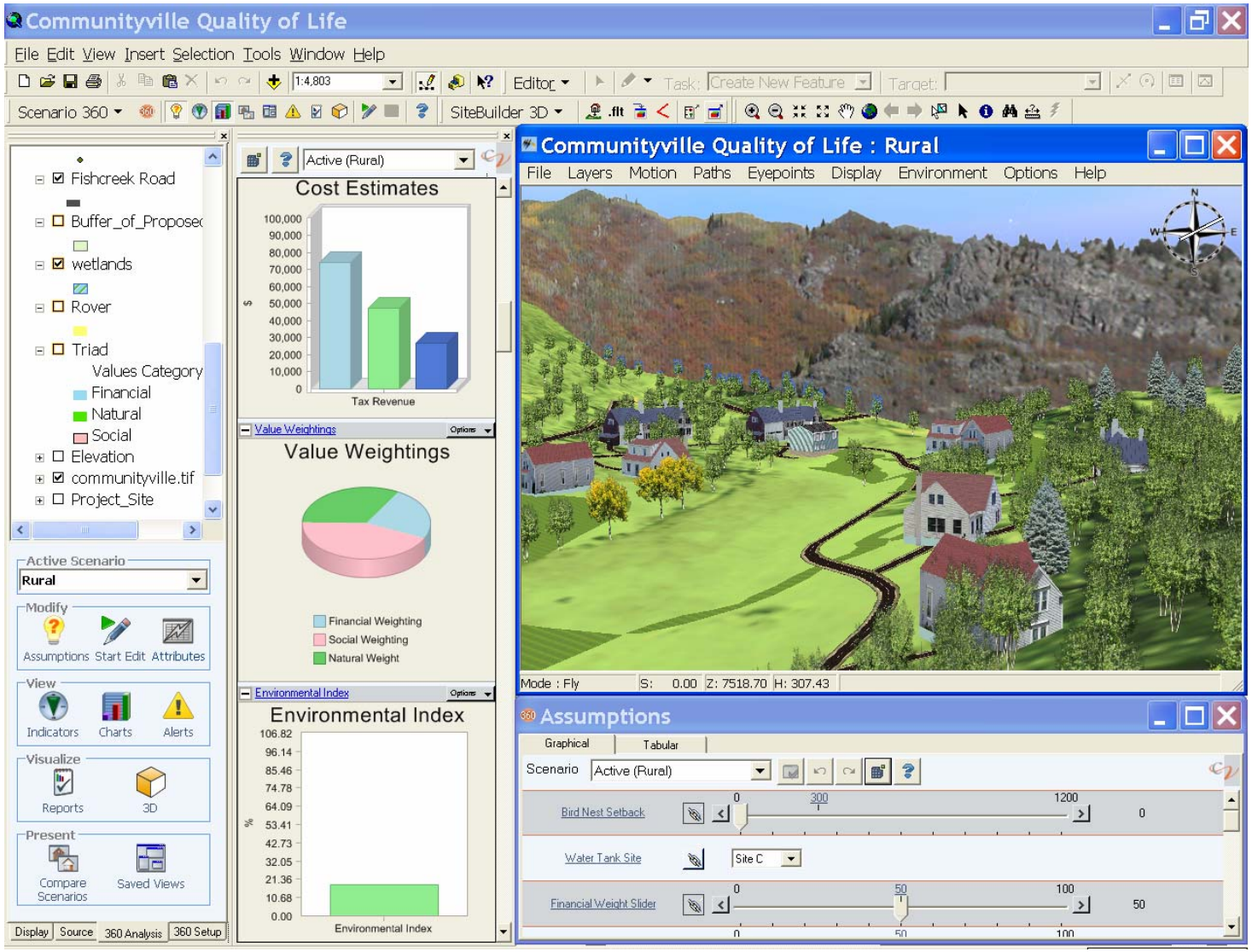
Planning Analysis, Tools & Implementation

Chula Vista Planning Process



Planning Analysis, Tools & Implementation

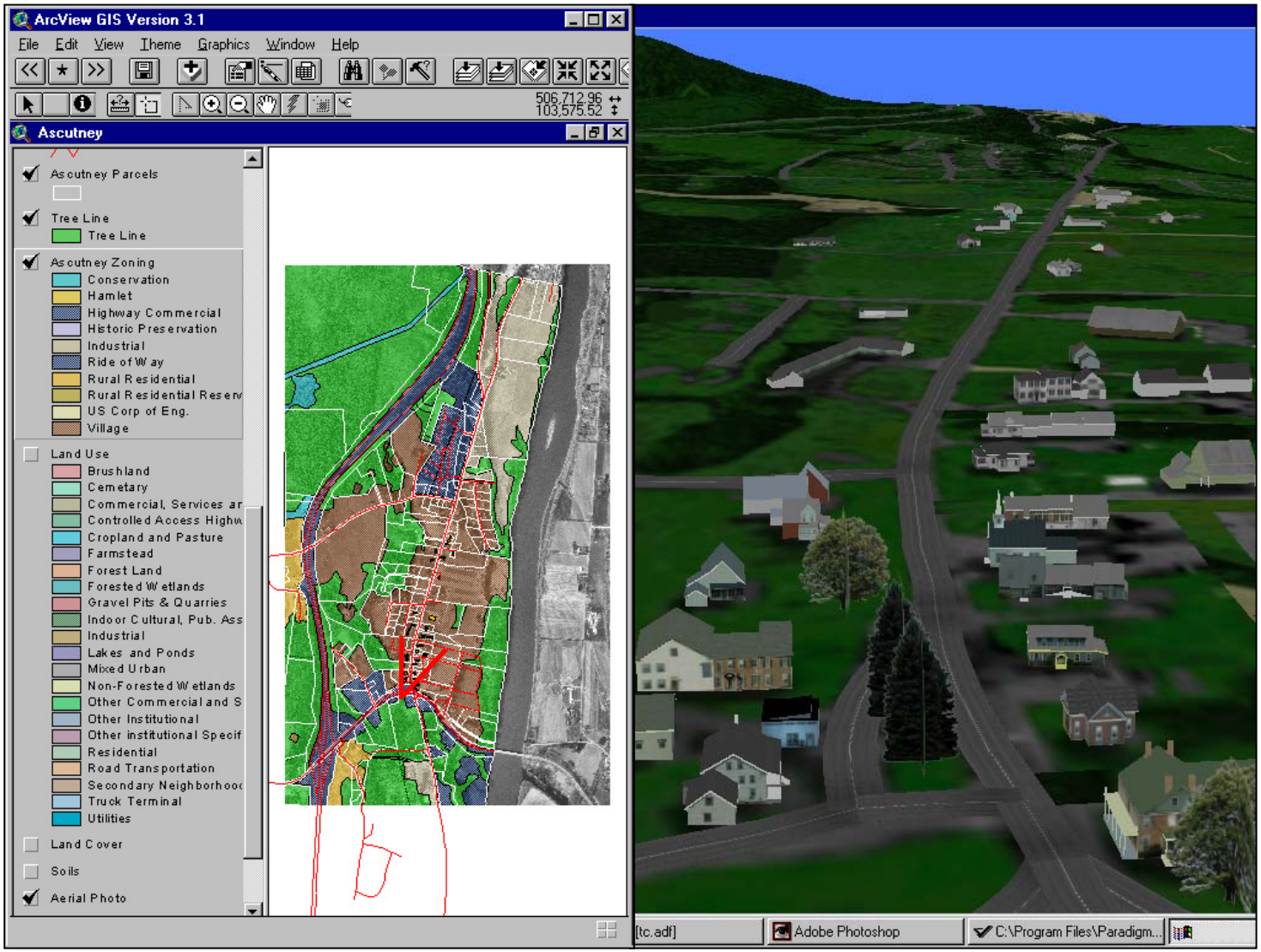
Design & Decision Tools



CommunityViz - Orton Family Foundation

Planning Analysis, Tools & Implementation

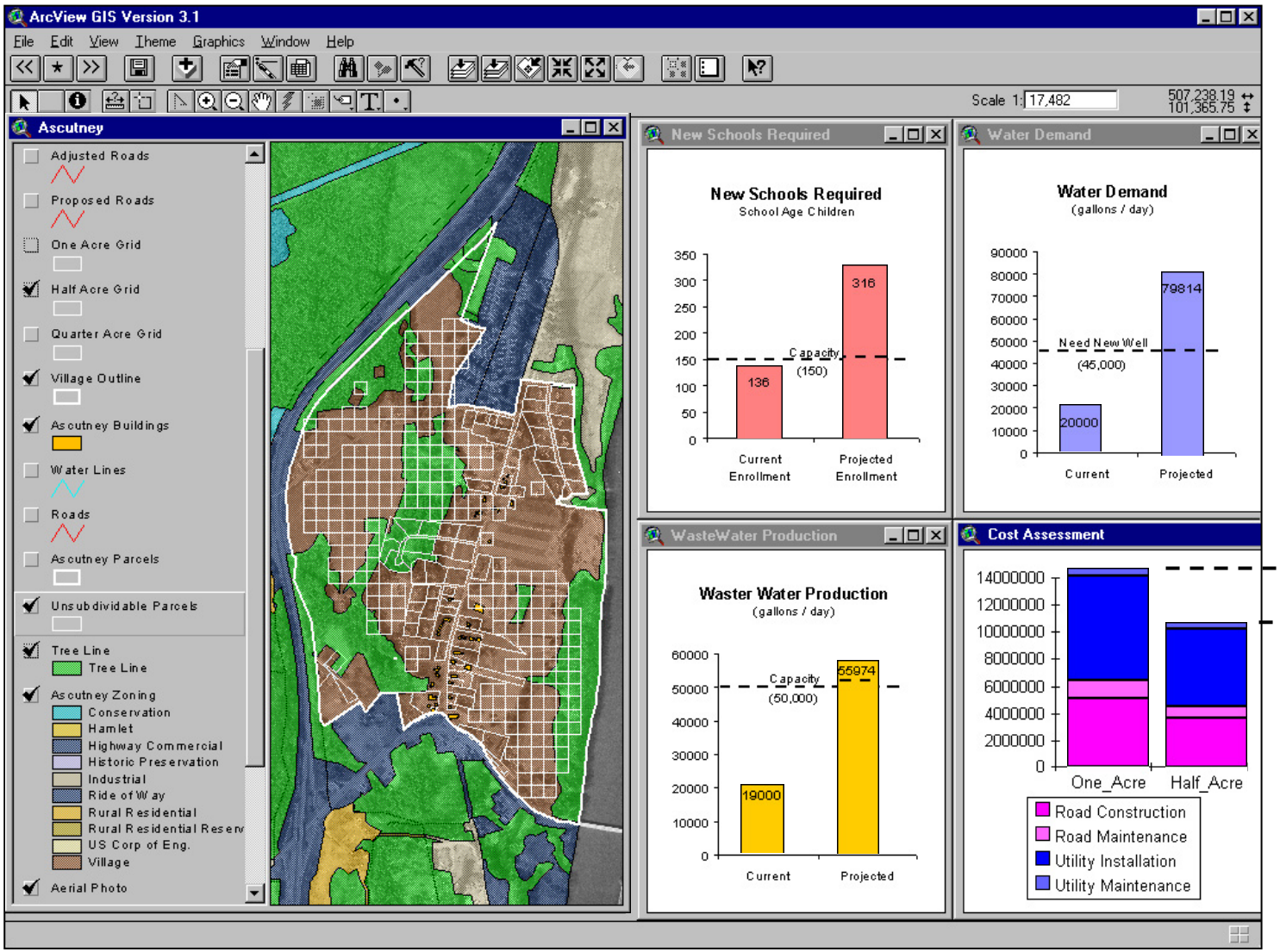
Design & Decision Tools



CommunityViz - Orton Family Foundation

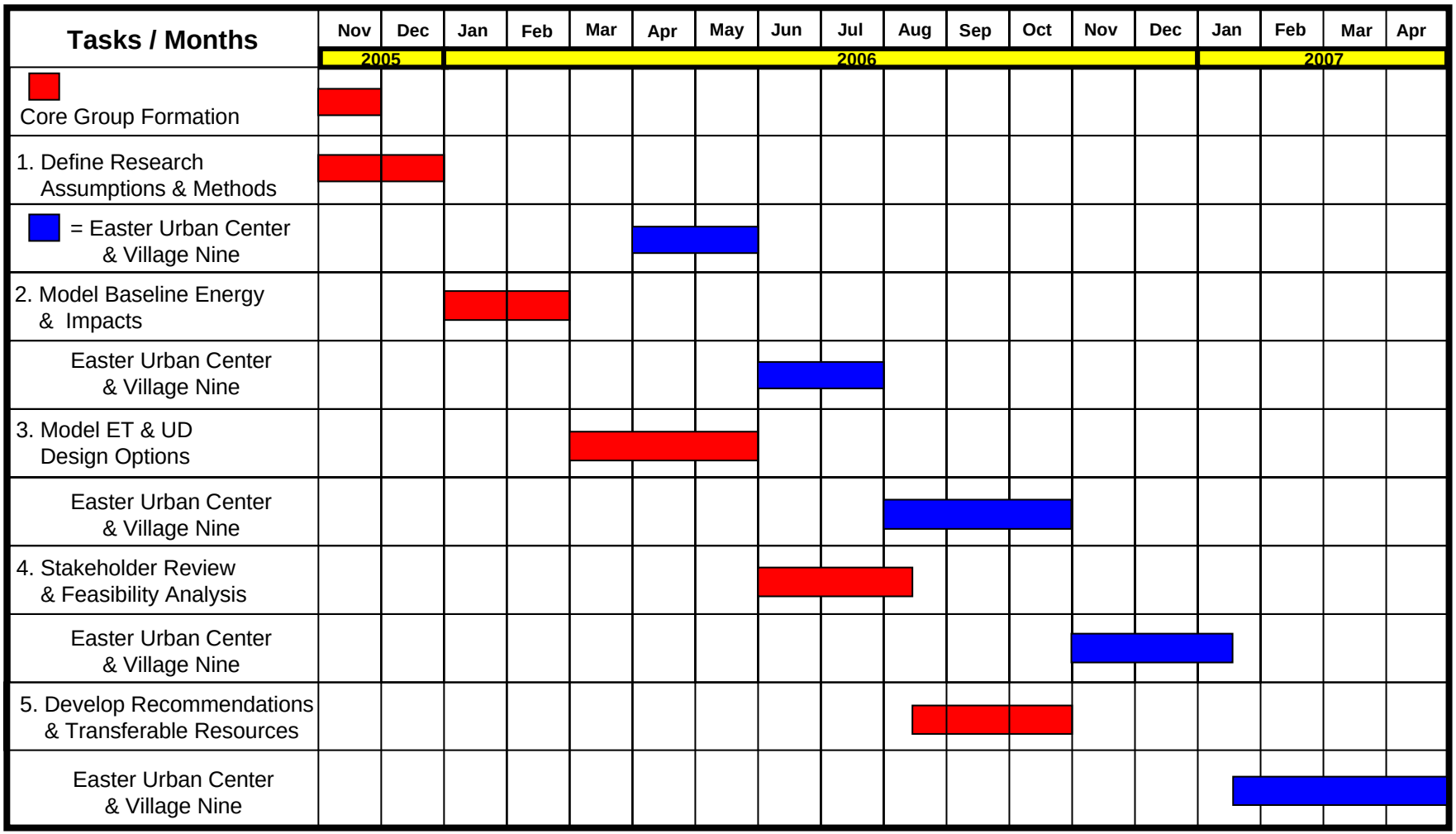
Planning Analysis, Tools & Implementation

Design & Decision Tools



Planning Analysis, Tools & Implementation

Chula Vista Planning Schedule



Participants & Funding

- Interdisciplinary Design Team
  - Elected & appointed officials, planners, architects, engineers, builders, brokers, buyers
- Community Stakeholders
  - City, county, regional & national officials, business & industry leaders, community groups, advocacy organizations & area universities
- Potential Sources of Funding
  - Energy research & development organizations
  - Energy utilities & technology manufacturers
  - National & international energy, housing, urban development, transportation & environmental protection agencies & private philanthropic organizations

Planning Analysis, Tools & Implementation

Policies, Programs & Incentives

1. Incorporate Energy-Smart development strategies in the community's comprehensive land use & economic development plans

2. Add urban heat island & stormwater assessment components to the community's land use survey to identify target areas for mitigation

3. Adopt cool roofs, surfaces & shade tree requirements for new building construction & community development projects

4. Adopt a green building design standard similar to the Leadership in Energy & Environmental Design or LEED-NC standard

5. Adopt a sustainable community design standard similar to the new LEED standard for Neighborhood Development (LEED-ND)

Policies, Programs & Incentives

6. Adopt urban growth & service boundaries (geographic limits on the provision of municipal services & infrastructure)

7. Develop & deliver a training program for the private development community on Energy-Smart development planning, design & technologies

8. Target existing high-density populations & enterprise centers for mixed-use villages & transit oriented development projects

9. Conduct a survey of the community's renewable energy & waste-to-energy potential & formulate a strategy for their development

10. Initiate a program to establish community-based recycling centers & to explore the potential for distributed energy & CCHP technologies & local area distribution

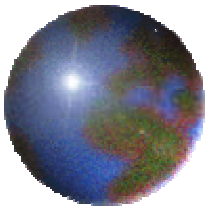
Policies, Programs & Incentives

11. Provide density bonuses to developers for adopting Energy-Smart development practices

12. Provide tax credits to builders & buyers incorporating & using energy efficient technologies, building materials & equipment in new building construction & renovation projects

13. Exempt renewable energy equipment such as solar water heaters & photovoltaic cells & storage from local taxes

14. Develop incentives such as expedited permitting, reduced fees & public recognition for real-estate developers who agree to comply with LEED-ND standards



Energy-Smart Community Development

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