Sustainable Infrastructure Transportation & Technology

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UHM - CEE - TTL

University of Hawaii at Manoa
Department of Civil and Environmental Engineering
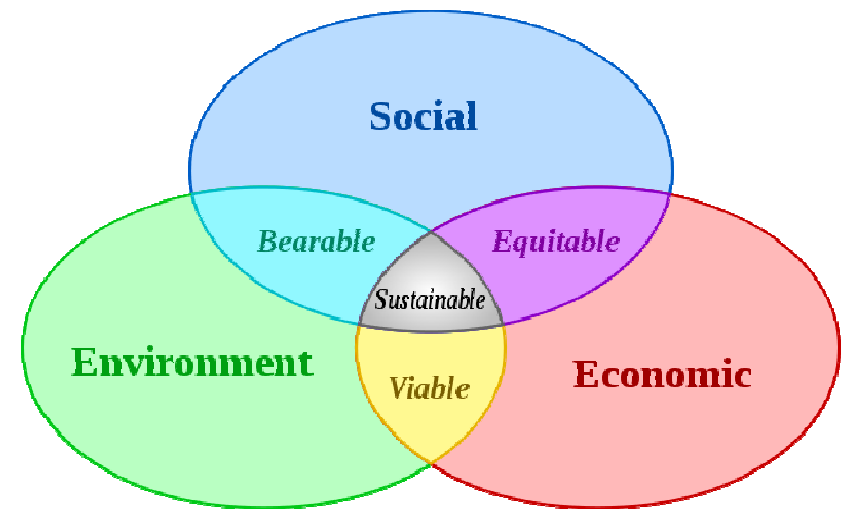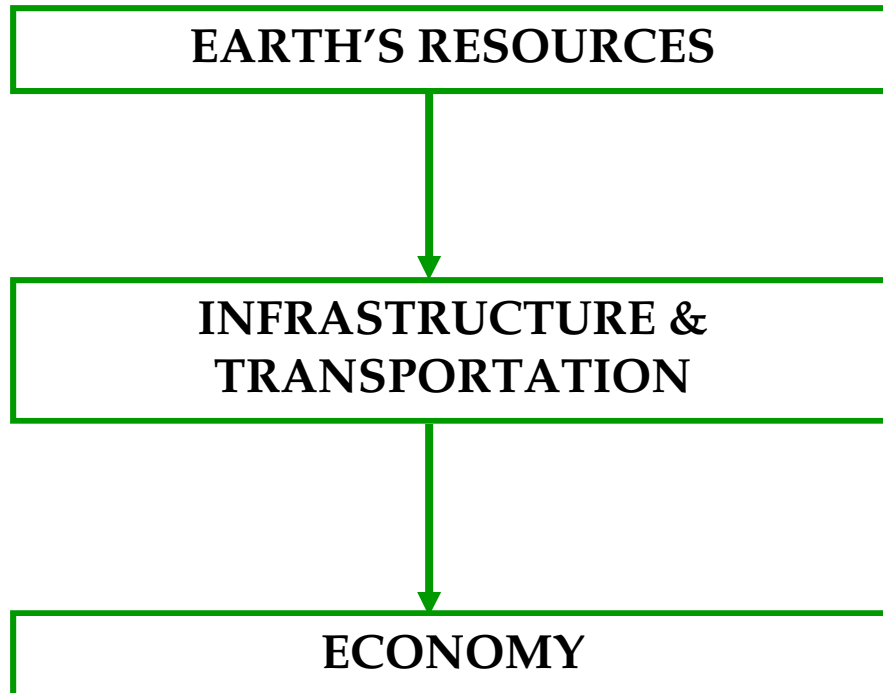Traffic and Transportation Laboratory

Why Sustainability?

Profound realization:

Oil depletion and climate change

- ◆ Where we live
- ◆ How we live
- ◆ How we grow food
- ◆ How we use energy
- ◆ How we travel

Fundamental Order

EARTH'S RESOURCES

↓

INFRASTRUCTURE & TRANSPORTATION

↓

ECONOMY

Sustainability Guidance

EU Council of Transport

- ❖ Limit emissions and waste within planet's absorption rate
- ❖ Max use of renewables
- ❖ Use non-renewable below the rate of developing renewables
- ❖ Min use of land and generated noise

State of Oregon (2006)

- ❖ Alt. fuel and hybrid light duty state vehicles
- ❖ Green bldg. policy
- ❖ Procurement that requires life cycle costs
- ❖ ODOT sustainability

- ❖ Create transportation systems compatible with native habitats and species and help restore ecological processes

- ❖ Develop and use technologies that reduce GHG

- ❖ **Impact of geological hazards and natural disasters including earthquakes, floods, landslides and rockfalls, on the efficiency and sustainability of the location**

- ❖ Reduce consumption of non-renewable construction materials, promote their efficient use and reuse, and reduce other impacts such as stormwater

- Use life-cycle costs in maintenance, purchase of equipment, selection of materials, and design
- **Prepare for possible fuel shortages**
- Videoconferencing [telecommuting / telework]
- Support compact urban design
- **Fill in missing gaps in sidewalk and bikeway networks**
- Facility designs that consider the needs of the mobility-challenged including seniors, people with disabilities, children and **non-English speaking populations**

❖ **Context Sensitive and Sustainable Solutions CS3:**

- recycling and reuse of materials
- renewable fuels
- optimization of life-cycle costs
- strengthening the state's workforce

❖ Health and Safety: sick and dead people cannot sustain society

❖ Gvmt. and edu office supplies, paper and electronic waste

❖ **Use non-fossil light duty vehicles**

From Roses to Roads

The **FCX Clarity** fuel cell vehicle is appearing more often on the streets of Southern California these days—from the Rose Parade to the realities of the daily commute—leaving behind only water vapor.

Hawaii's Many Challenges

- ❖ **Most dependent on oil among 50 states… Big Island geothermal ~30% … Oahu waste-to-energy ~20% … overall solar ~0.1%**
- ❖ **Hawaii residents pay among the nation's highest rates for electricity and fuel → cost/income disparity**
- ❖ **Import food and materials for construction → over 90%**
- ❖ **Tourism contribution to GSP: 35%-50%**
- ❖ **Dependency on earmarks: HIGH for Hawaii, VERY HIGH for University of Hawaii → outlook past 2014?**
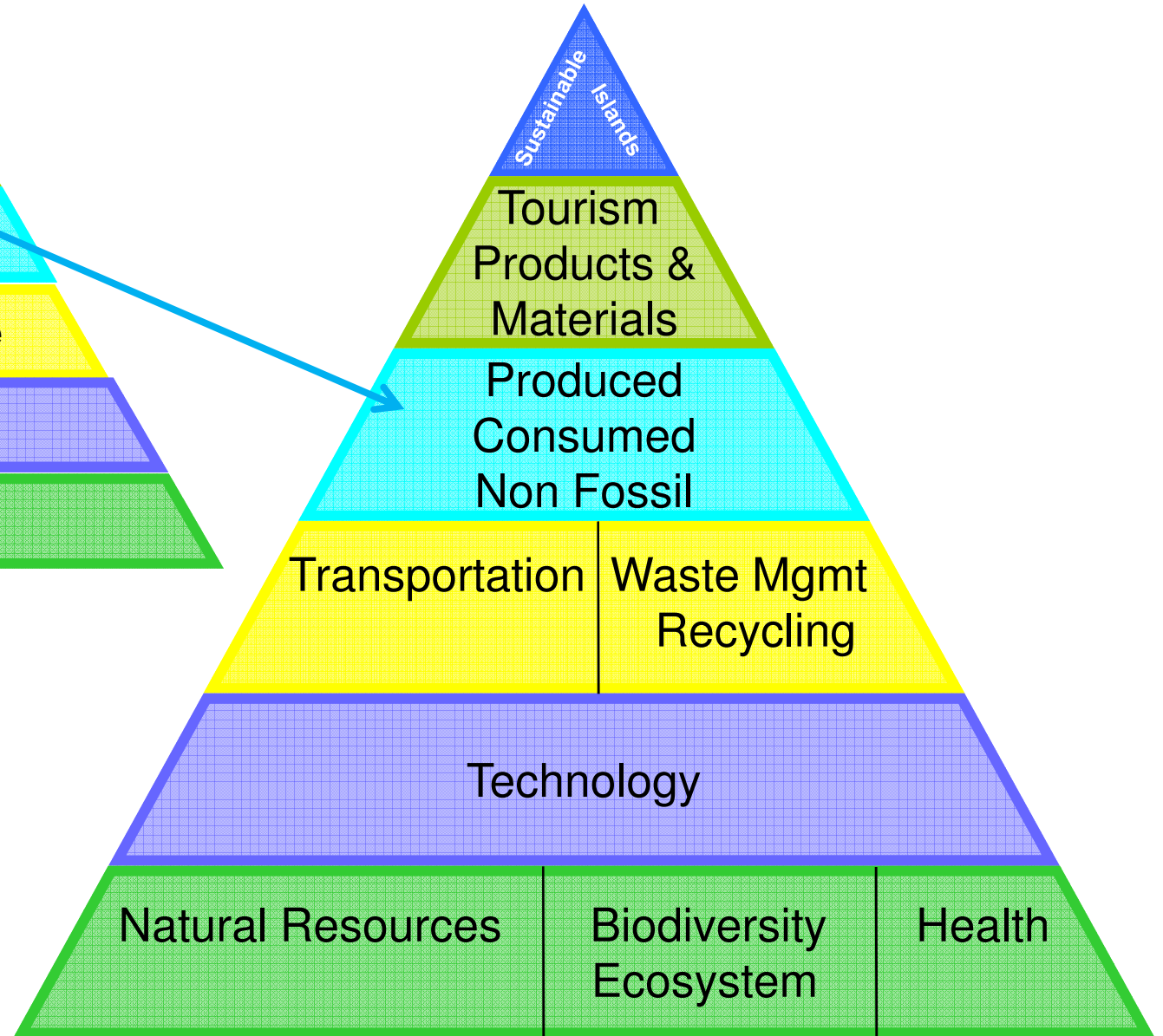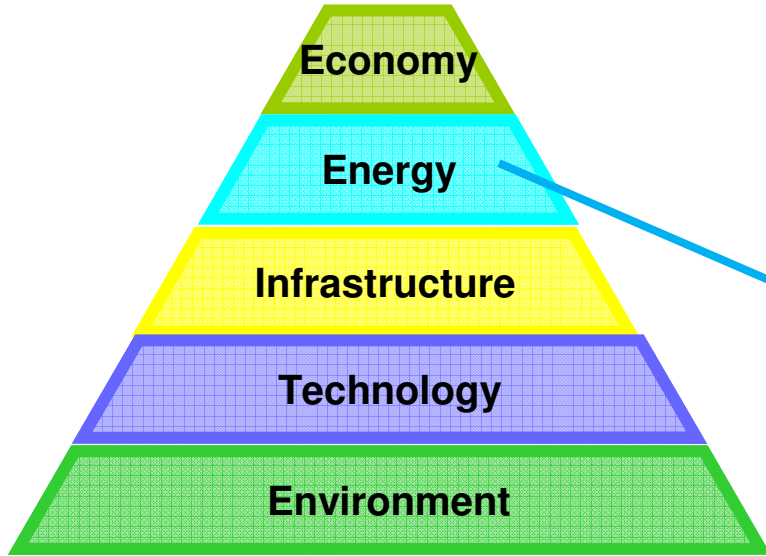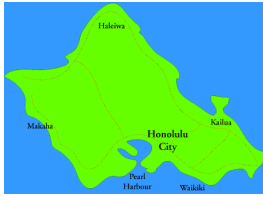- ❖ **Extremely sensitive to sea level rise**
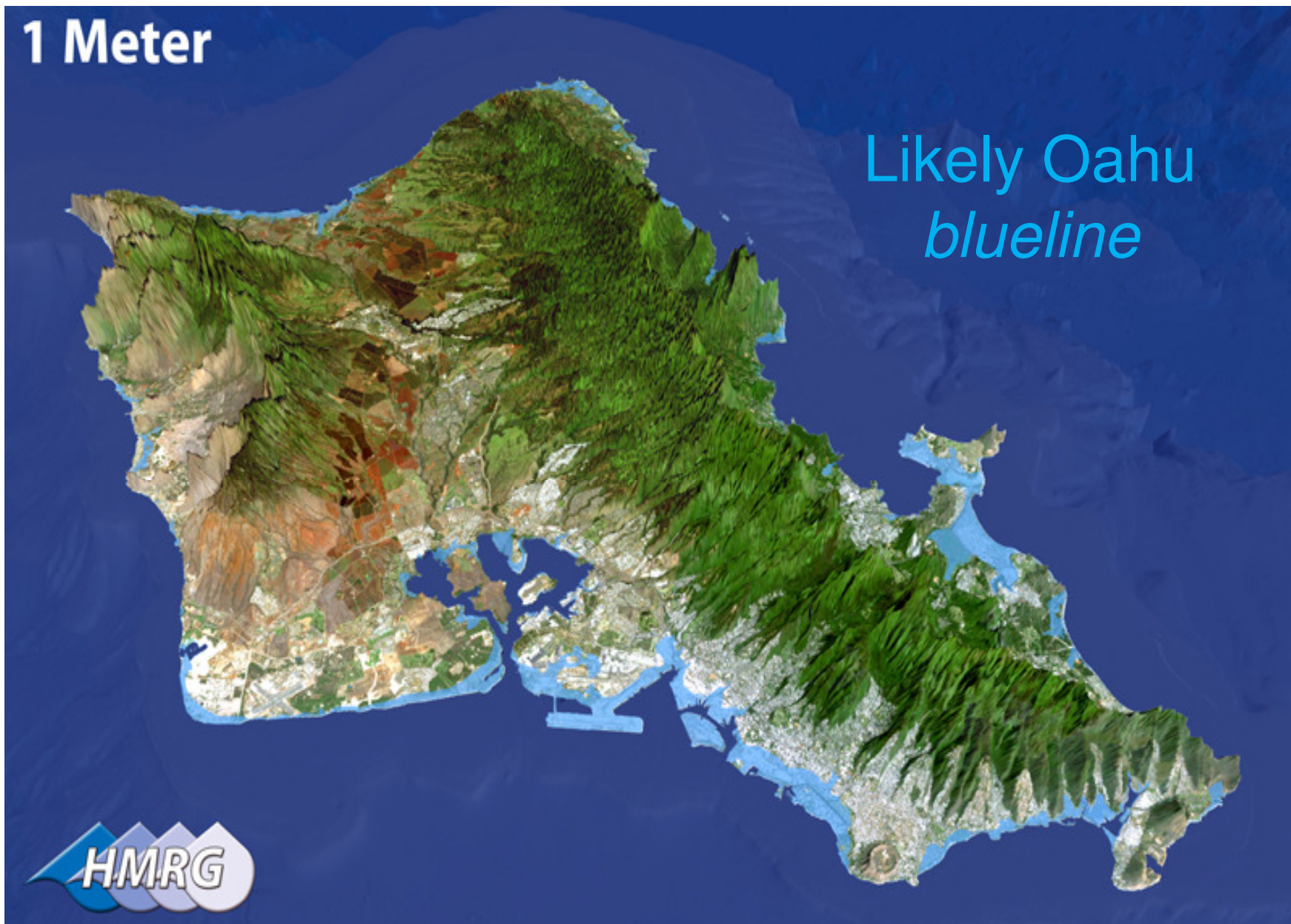
	Island	Population
1	Azores-San miguel	140,000
2	Bahamas-N.Providence	307,000
3	Big Island	148,677
4	Corfu	107,897
5	Corsica	281,000
6	Crete	623,666
7	Cyprus	1,048,000
8	Gran Canaria	802,257
9	Guadaloupe	408,000
10	Ibiza	113,908
11	Ireland	4,422,100
12	Jamaica	2,804,332
13	Mallorca	790,763
14	Malta	419,285
15	Martinique	401,000
16	Maui	117,644
17	New Zealand	4,280,000
18	Oahu	899,593
19	Puerto Rico	3,994,259
20	Rhodes	117,007
21	Sardinia	1,665,617
22	Sicily	5,029,683
23	Tenerife	852,945
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Left pyramid (top to bottom):
- Economy
- Energy
- Infrastructure
- Technology
- Environment

Right pyramid (top to bottom):
- Sustainable Islands
- Tourism Products & Materials
- Produced Consumed Non Fossil
- Transportation | Waste Mgmt Recycling
- Technology
- Natural Resources | Biodiversity Ecosystem | Health

What Can We Do at UHM?

S.I.T.T. Program

Sustainable

INFRASTRUCTURE

Roads and Bridges

Harbors and Airports

• Threats and resilience to fatigue, earthquake, accidental or terrorist damage, climate forces

• Infrastructure health monitoring

Recycling

• Pavements, concrete, rebar, glass, H-Power flyash

• Solid waste mgmt

Green Buildings

• Methods, materials, energy, reuse

• Improvements to the vast existing inventory

New Energy Infrastructure

Waste, solar, wave, wind, OTEC, nuclear power plants

TRANSPORTATION

Roads and Bridges

Harbors and Airports

Traffic Controls

• Threats and resilience to tsunami, hurricane, flooding (short term)

• 21st century upgrades

• Emergency mgmt and recovery

• Health and safety of residents and tourists

Sea Level Rise

• Survival, serviceability in long term flooding

Fuels and Energy

• Electric vehicles and infrastructure

• Biofuels for sea and land modes

Freight transport with oil at $200/barrel

TECHNOLOGY

• Non-fossil fuel energy: chemical (fuels &additives,) solar, wind, wave, compact reactors, LNG, fusion, …

• Desalination

• Cooling technology

• Kite for Sail

• Micro and nano devices

• The $2,500 Tata Nano

• Dirigibles? ("Zeppelin")

• And so much more that we will discover in the future… The automobile is only 100 years old and the PC is about 25 years old.

What does the future hold?

• **Personal public transit?**

• **Telework?**

• **Re-urbanization?**

On UniModal's SkyTran™ you travel the city using a network of elevated guide-ways on which small, computer controlled, magnetically levitated vehicles provide you with point-to-point, non-stop, on-demand transit service.

Fast: SkyTran utilizes line capacity more efficiently than light rail by moving the vehicles in a continuous stream. Every part of the line is continuously utilized network as opposed to light rail, where each line segment is utilized only for a few seconds when the train passes over it and then repeatedly sits idle at each station. When compared to the highway infrastructure, a SkyTran guideway has the same capacity as three lanes of freeway traffic.

Energy Efficient : Gliding on no-contact, friction-free maglev bearings, the light plastic composite two-passenger vehicles add to energy efficiency by reducing wind resistance and drag through their aerodynamic design. This attention to vehicle shape and size allows for their suspension on narrow, lightweight, visually unobtrusive aerial guideways supported by standard utility poles with a very small right-of-way footprint.

Safe: There are no intersections where pedestrians or surface vehicles can collide with SkyTran because the system is elevated and the vehicles themselves run in only one direction eliminating the threat of vehicle collisions. The guideway's patented design "captures" the maglev-motor assembly in such a way that makes vehicle derailments impossible. Computer controlled collision-avoidance radar and guideway sensors update thousands of times per second to maintain proper position and speed with other vehicles.

SKYTRAN 3D NETWORK
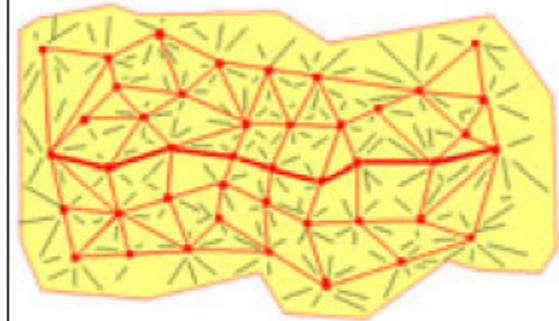
SkyTran is laid out across a city in an elevated 3-D network configuration (above). You can get from any one point in the city to any another by a variety of different routes. And getting to any stop is only a short walk. In contrast, typical light rail design (below) serves an extremely limited number of stops, leaving most of the city without service.
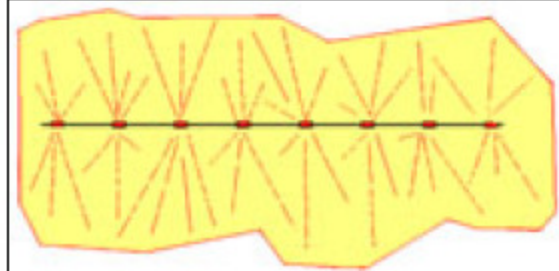
TTWISE: the six pillars of island sustainability

Tourism, Technology, Waste management, Infrastructure, Supply chain, Energy

Tourism
- Healthy and productive local economy
- Good local transportation
- Wide beaches, free of microbes
- Reliable infrastructure
- Fast and affordable long haul transportation

Energy
Non fossil and renewable for:
- Local travel
- Interisland travel
- Long haul travel
- Local transportation
- Residences
- Industry

Waste Management
- Office
- Residential/hotel
- Industrial/commercial
- Demolition: buildings, pavements
  - Reuse rebar and aggregates
- Yards, roads, parks and forests
- Sewer waste
  - Reclaim and reuse

Technology
- Is the major enabler for long distance, interisland and local transportation, energy supply, human-flora-fauna health, waste management and infrastructure monitoring
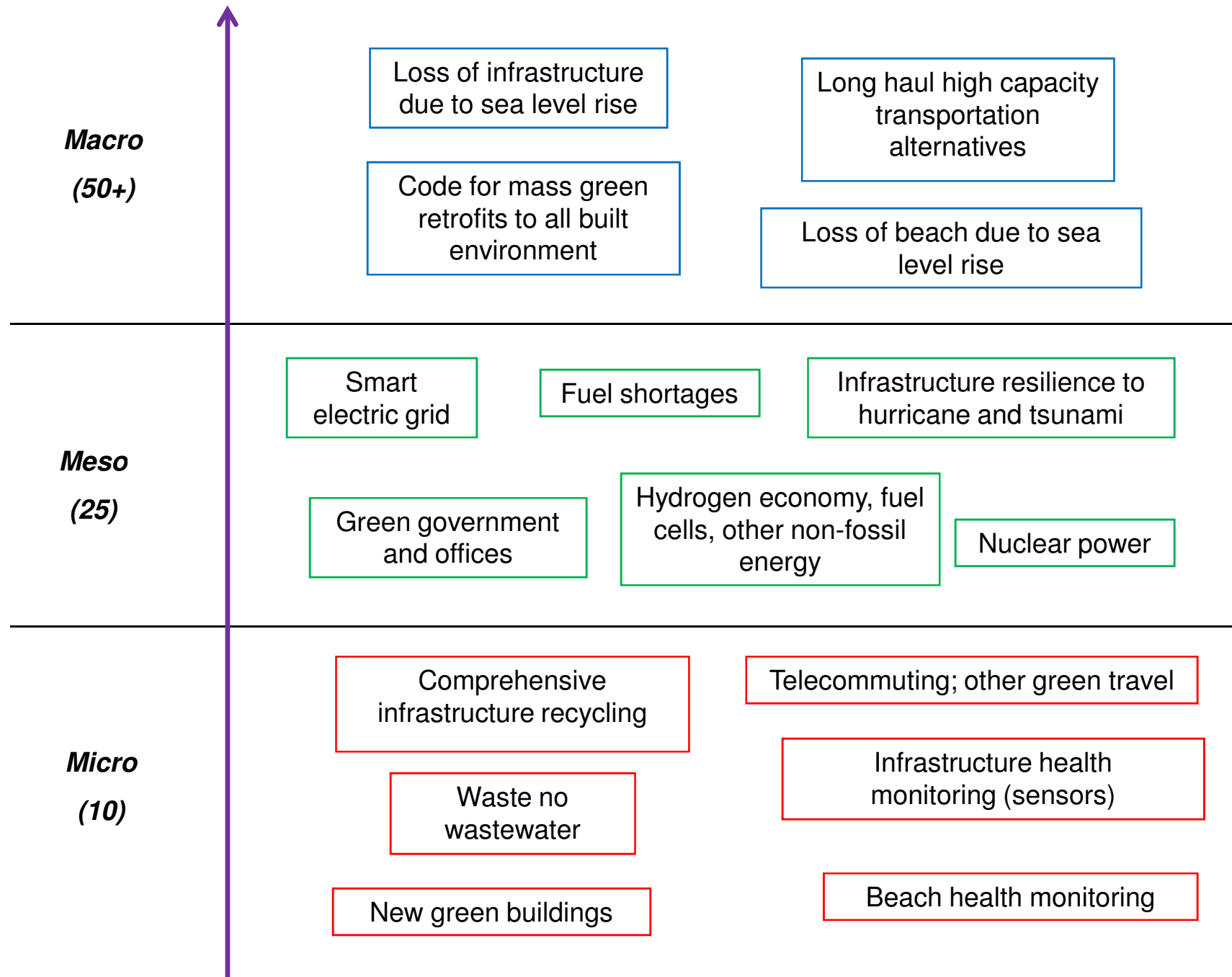
Supply Chain
Food and Consumer Goods
Construction materials, Parts, ...
- Long haul transportation
- Adequate harbors and warehousing

Infrastructure
- Climate change
- Resilience to major risks
- Resilience to time
  - Building life 250 years, design 50 years

Approximate time scale

Macro

(50+)

Loss of infrastructure due to sea level rise		Long haul high capacity transportation alternatives
Code for mass green retrofits to all built environment		Loss of beach due to sea level rise

Meso

(25)

Smart electric grid	Fuel shortages	Infrastructure resilience to hurricane and tsunami
Green government and offices	Hydrogen economy, fuel cells, other non-fossil energy	Nuclear power

Micro

(10)

Comprehensive infrastructure recycling	Telecommuting; other green travel
Waste no wastewater	Infrastructure health monitoring (sensors)
New green buildings	Beach health monitoring

Involved Disciplines

- **Civil Engineering**: structures, traffic mgmt, ITS, pavements, green bldgs, recycling, materials
- **Electrical Engineering**: Sensors, solar energy, electric vehicles, smart power grids
- **Mechanical Engineering**: Methods, materials, corrosion
- **HNEI**: Biofuels, energy alternatives
- **Travel Industry Management**: sustainable tourism, supply needs, capacities, threats
- **Law**: Environmental, transportation, international law
- **Economics**: Demand, forecasts, pricing, evaluation
- **Geophysics**: Inundation zones (tsunami, hurricane flood or sea level rise)

SITT

Sample Hawaii-based Tech

- Sail-assisted boating

- Activated carbon
- Green waste → energy
- Eco-tourism
- Water/gravity electricity
- Carpooling "lottery"

- Greener gvmt. offices
- Greener schools
- Green resorts
- Building code updates
- Signal timings for energy ↓
- Solar, wind, wave energy
- Small nuclear reactors
- Flood response
- Electric car–*BetterPlace.com*
- Large scale reuse: glass, oils, pavements, demolition materials…

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Exportable Knowledge

Sustainable directions for heavily populated island communities:

- ❖ Diversity of energy resources
- ❖ Solar energy: direct and through green waste
- ❖ Emphasis on renewable propulsion (green boosters or fuels)
- ❖ Updated codes for urban areas (green codes)
- ❖ Optimization of urban travel (green travel)
- ❖ Decrease solid and liquid wastes through re-use and remanufacturing of useful products
- ❖ Survive fuel shortages and floods

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UHM Role

- Quantifying the environmental, economic & technical tradeoffs of energy technologies & policies
- Addressing the utility concerns for system stability and reliability; operational and planning issues
- Creating an ability to analyze "What-If" scenarios
- Creating new technologies and spin-off technologies
- Simulating the energy trends of the next 20 years: population, oil supply and pricing, economy and technology

- Educating Hawaii and global experts (graduate students and faculty)

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We make a living by what we get.
We make a life by what we give.

Sir Winston Churchill

QUESTIONS?

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