Sustainable Infrastructure Transportation & Technology

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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

Social

Environment

Economic

Bearable

Sustainable

Equitable

Viable
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

- 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

Govmt. and edu office supplies, paper and electronic waste

Use non-fossil light duty vehicles
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
1 Meter

Likely Oahu blueline
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What Can We Do at UHM?
S.I.T.T. Program

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…

- Personal public transit?
- Telework?
- Re-urbanization?
On UniModal's SkyTran™, you travel the city using a network of elevated guideways 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 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
- Code for mass green retrofits to all built environment
- Long haul high capacity transportation alternatives
- 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)
Sample Hawaii-based Tech

- Sail-assisted boating
- 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...

- Activated carbon
- Green waste → energy
- Eco-tourism
- Water/gravity electricity
- Carpooling “lottery”
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
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)
We make a living by what we get.
We make a life by what we give.

Sir Winston Churchill