Systems Practices for Sustainability

Walter Sobkiw

Quadrennial Defense Review (QDR) Report February 2010

From Crafting a Strategic Approach to Climate and Energy

- The U.S. Global Change Research Program
  - Composed of 13 federal agencies, reported in 2009
- Climate-related changes being observed in every region of world, including US and its coastal waters
- Among physical changes are increases in
  - heavy downpours, rising temperature and sea level
  - rapidly retreating glaciers, thawing permafrost
  - lengthening growing seasons, lengthening ice-free seasons in oceans and on lakes and rivers, earlier snowmelt
  - alterations in river flows

Quadrennial Defense Review (QDR) Report February 2010 Fort Carson, Colorado

- Army partnered with local energy provider
- Photovoltaic solar array on top of a closed landfill
- Provides energy to 540 homes

Take Away

What can systems engineering do to facilitate sustainable development and the policy and goals in this report

Sustainability

Brundtland Commission

Meets the needs of the present without compromising the ability of future generations to meet their own needs

Approaches

- Product driven
  - Products are a perfect fit in a particular niche of sustainability
- Technology driven
  - Magic technology solving a challenging sustainability issue
- Financial driven
  - Tax incentives or virtual markets will spur innovation and let business rise to the occasion of various sustainability needs
- Systems driven
  - Systems engineering to start to chip away at this problem
- Challenge - who will do the systems engineering?

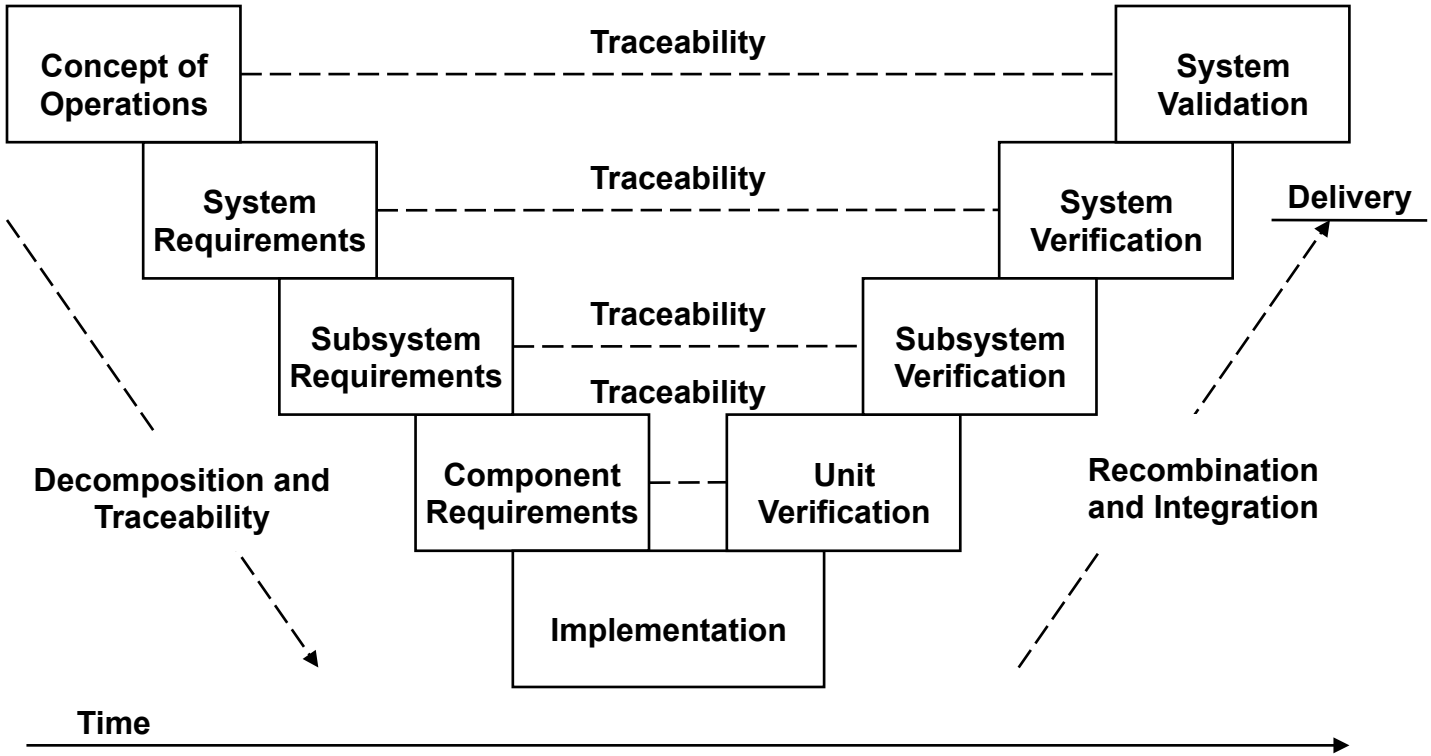
Systems Practices for Sustainability

- Sustainable V Diagram
- Community Sustainability Concept & Accountability
- Sustainable Requirements
- Technology Assessment, Innovation, and Stability

- Modeling and Prototyping
- Maintainability, Logistics, Safety, Reliability, Quality
- Life Cycle Cost
- Architecture Identification Tradeoffs and Selection

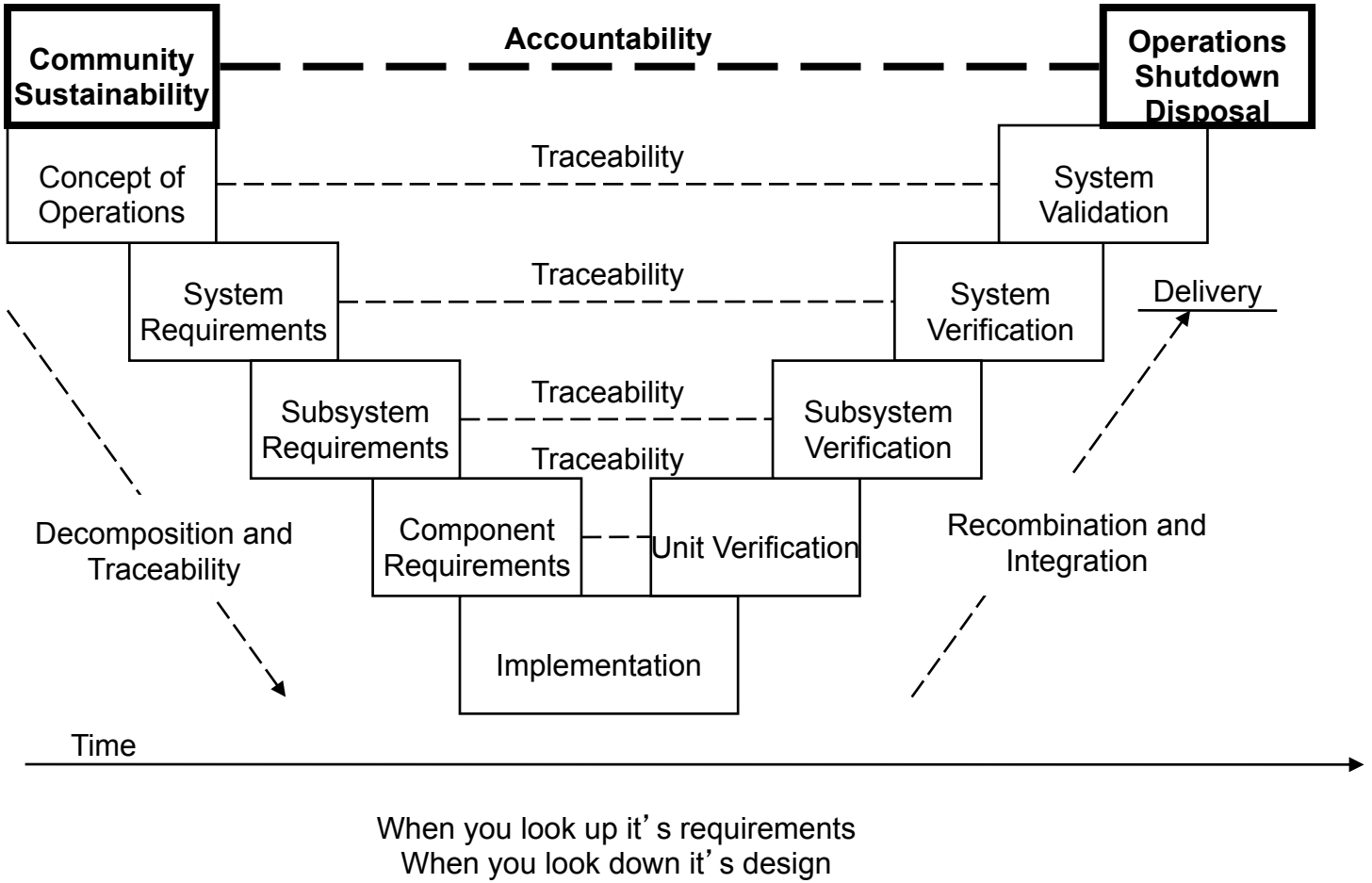
- The Context Diagram

Traditional V Diagram



When you look up it's requirements
When you look down it's design

Sustainable V Diagram



Community Sustainability

- Concept is not new
- Environmental impact studies
  - Ref: National Airspace System Engineering Manual, Federal Aviation Administration, V 3.1, 2006.
- Army **I**nstallation **S**ustainability **P**lans (ISPs)
  - Ref: Developing Headquarters Guidance for Army Installation Sustainability Plans in 2007 - RAND Corporation
  - Army installations in early 2000's started to develop ISPs
  - RAND reviewed these plans and suggested a common template for moving forward

Ref: Systems Practices as Common Sense, Walter Sobkiw, July 2011.

Community Sustainability

- Proposed Content - stakeholders
  - Who are the stakeholders
  - What are the stakeholder needs
  - What are the key sustainability issues in this system
  - What are the sustainability goals in this system
  - What are the key sustainability and stakeholder requirements
  - What is the accountability path for poor sustainability
- Proposed Content - practices
  - Sustainable Requirements
  - Technology Assessment, Innovation, and Stability
  - Modeling and Prototyping
  - Maintainability, Logistics, Safety, Reliability, Quality
  - Life Cycle Cost
  - Architecture Identification, Tradeoff, and Selection

Sustainable Requirements

What new functional and more importantly performance requirements are needed moving forward?

- Perform literature searches, vendor searches and vendor assessments in alternative energy sources, transportation vehicles, fuels, etc.
- Find discriminators between various offerings
- Discriminators are new requirements categories
- For example in a wind farm
  - Minimum maximum useful wind speed
  - Watts per footprint area, linear height, unit of weight

Possible General Sustainable Performance Requirements

- Packaging Carbon Footprint (PCF)
- Transport Carbon Footprint (TCF)
- Content Carbon Footprint (CCF)
- Packaging / Content Carbon Ratio (PCCR)
- Transport / Content Carbon Ratio (TCCR)

- Goal is to minimize total loads and ratios in system
  - If total load of PCF + TCF + CCF is minimized and yet packaging is so small that content is “less” than package, then question must be asked - is system violating basic common sense related to sustainability

Ref: Systems Practices as Common Sense, Walter Sobkiw, July 2011.

Technology Assessment, Innovation, Stability

- Technology assessment includes
  - Identifying technology maturity levels [Rogers 1962]
  - Determining Technology Readiness Levels (TRL) [NASA 2007, DOD TRA 2009] of various system elements
- When vendor solutions are identified and characterized
  - Performance requirements become candidates for improvement
- At this point systems integrator moves from commercial product consumer to technology developer while attempting to push technology development and growth

Modeling and Prototyping

- Evaluate different architectures and technologies

- HOMER [NREL 2011]
  - Energy modeling for hybrid renewable energy systems
  - Conventional generators, co-generation, wind turbines, solar photo voltaic, hydropower, batteries, fuel cells, biomass, and other inputs
  - National Renewable Energy Lab (NREL)

- The Solar System Test and Engineering Site (SolSTES)
  - Integrate and test solar technologies and materials
  - Field test-bed in Moorestown, New Jersey at Lockheed Martin

Maintainability, Logistics, Safety, Reliability, Quality

- Current systems are extremely maintainable, supportable, safe, reliable, and of high quality
  - Decades of evolution bought them to this state
- New systems based on displacement technology do not have luxury of decades of evolution
  - Must also be highly maintainable, supportable, safe, reliable, and of high quality
- This is a challenge

Life Cycle Costs

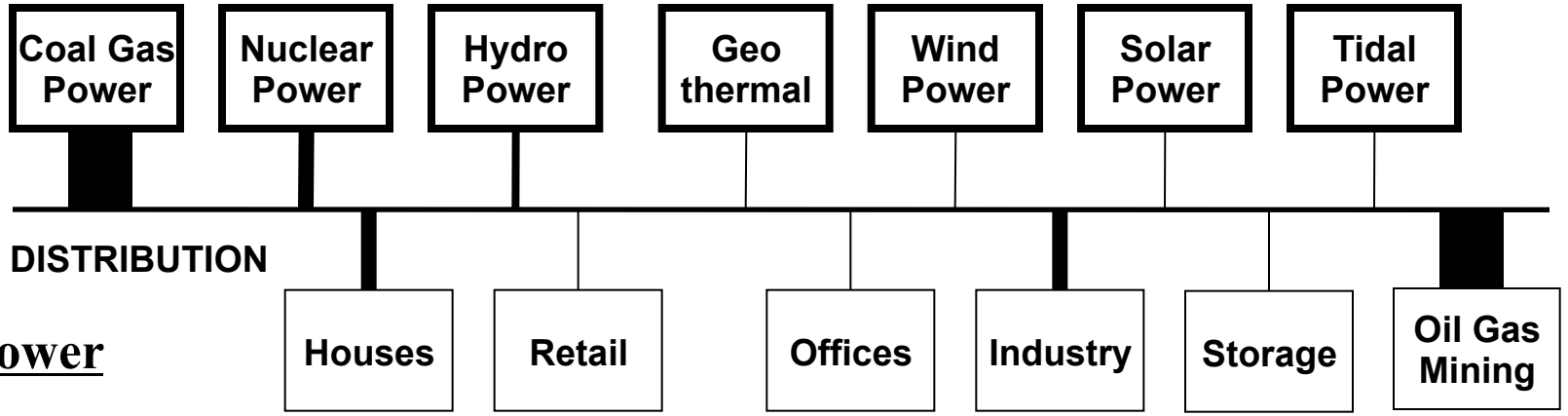
- LCC = **R+D+P+O+M**+W+S+T Where:
  - **R = Research**
  - **D = Development**
  - **P = Production**
  - **O = Operation**
  - **M = Maintenance**
  - W = Waste
  - S = Shut Down and Decommissioning
  - T = Disposal

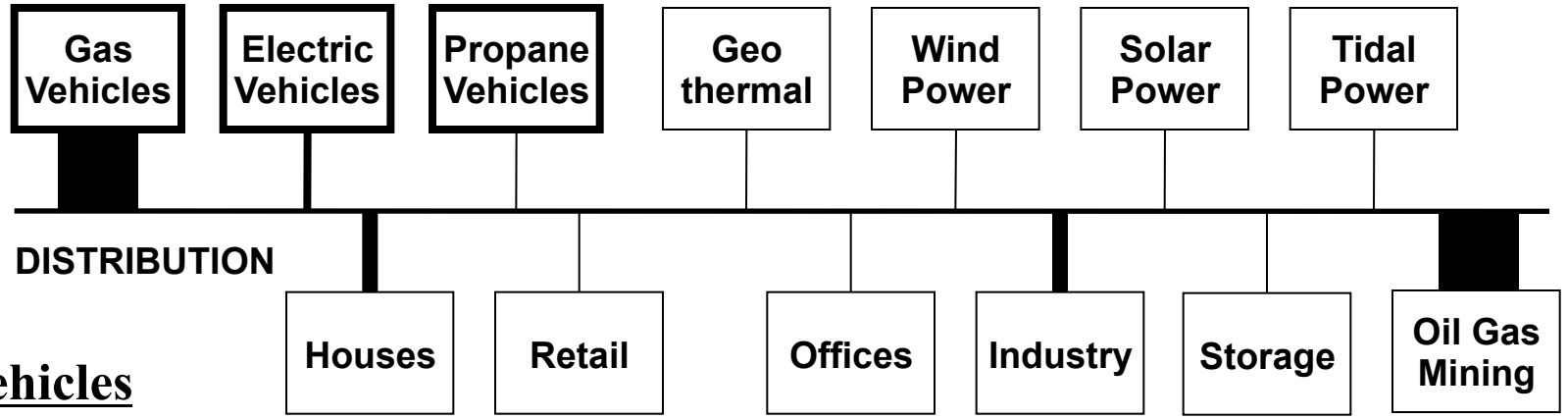
Who pays for the Indirect Costs?

Sustainability Architecture Tradeoff Criteria

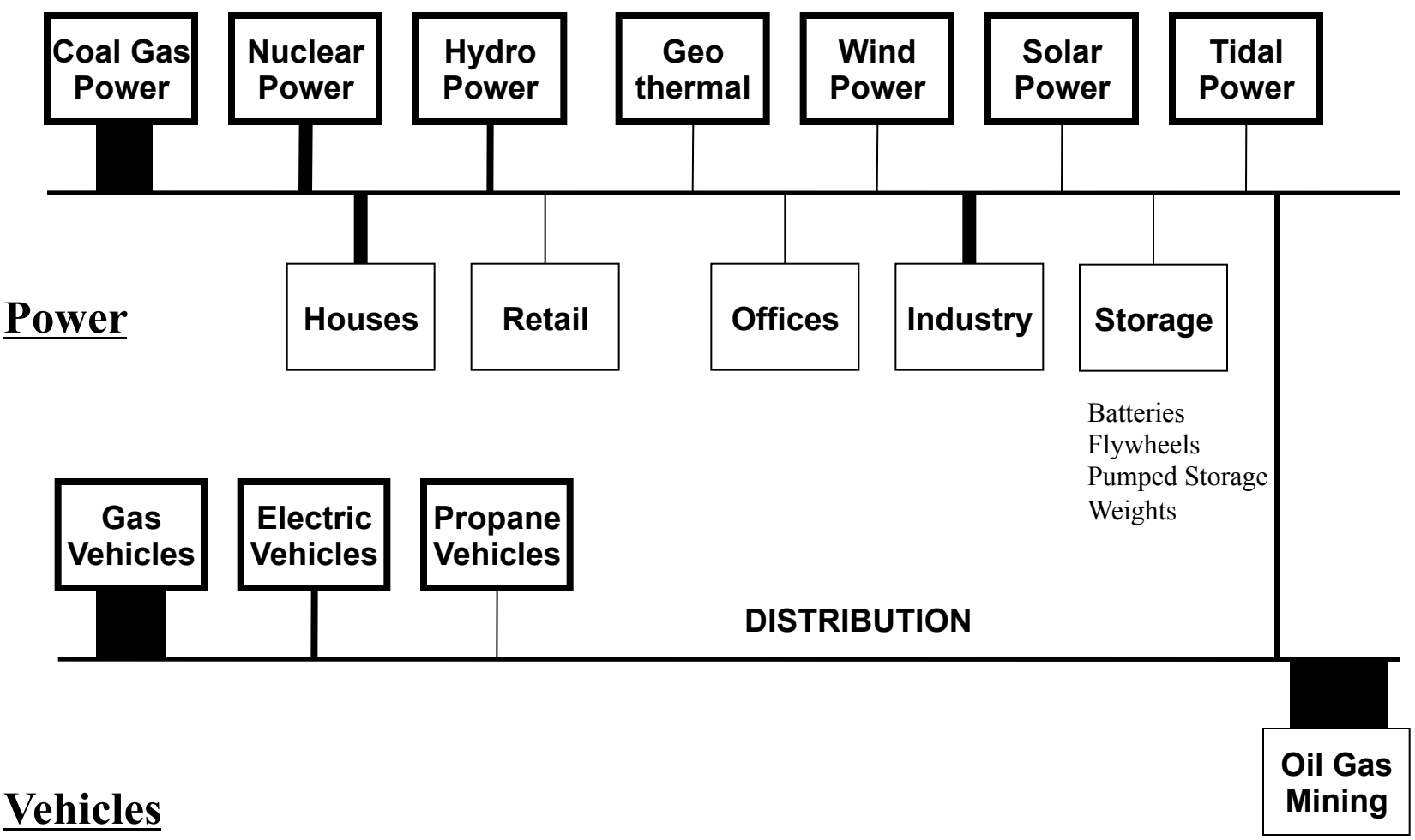
- Air, land, water, sea, space, outer atmosphere environmental impact
- Water, land, air, noise, visual pollution
- Fuel and carbon sustainability
- Internal and external sustainability, regeneration
- Cost shifting (to other stakeholders)
- Technology maturity, stability, growth potential
- Model results, maintainability, produceability, supportability, quality
- Aesthetics, form, user acceptability
- Population growth, standard of living, social mobility, quality of life, happiness, survivability

Architecture Depiction 1





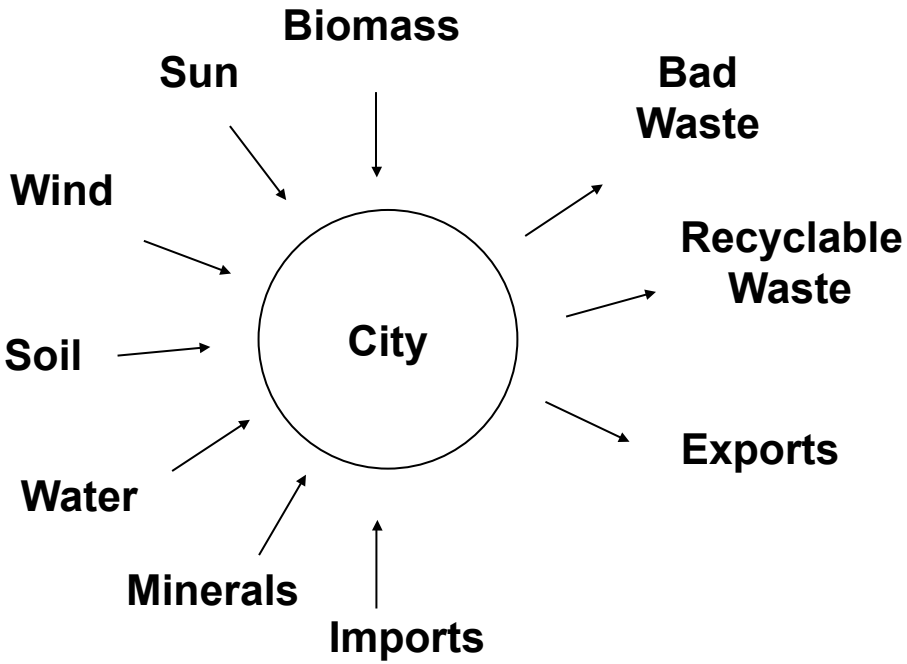
Architecture Depiction 2



Architecture Tradeoff

- Value Systems
  - Financial value systems (e.g. lowest cost, greatest return on investment, highest profit, etc)
  - Some value a day at the beach more than at the mountains
- Tradeoff Criteria
  - Starts with advantages disadvantages lists
- Costs
  - Initial, life cycle costs, indirect costs, direct costs, cost shifting
- Measure of Effectiveness (MOE) = sum of tradeoff criteria / life cycle costs

Is there a set of patterns that can be used to establish the context of a system when addressing sustainability?



Links

- walt.sobkiw@cassbeth.com
- www.cassbeth.com
- www.cassbeth.com/book
- www.cassbeth.com/book-2
- Books on amazon.com:
  - Sustainable Development Possible with Creative System Engineering, Walter Sobkiw, 2008.
  - System Practices as Common Sense, Walter Sobkiw, July 2011.