Socio-Technical Systems, Appropriate Technology, and the Capability Approach – Assessing Energy Solutions in Puerto Rico"

William J. Frey

University of Puerto Rico at Mayaguez

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CRW-STEM

Cultivating Responsible Wellbeing in STEM: Social Engagement through Personal Ethics

NSF SES-1449489

"Engineering/Design for Development and Well-being/Agency/Justice"

October 2, 2014
Society for Ethics Across the Curriculum
Scottsdale, Arizona

Agenda

- Energy situation in Puerto Rico
  - Four proposals, two rejected, two developed
  - Dependence on imported oil
- Socio-Technical System in Puerto Rico
  - Surrounds (bio, physical, social) that constrain and enable)
- Outline a framework for teaching energy ethics
  - Zoom in, zoom out, Appropriate Technology, and Capabilities
- Capabilities
  - **Vulnerability**
  - **Practical Reason**
  - **Sociability**
  - **Not NIMBY but…**

Giving voice to

Social Justice

Free and Informed Consent

Appropriateness

Environmental Impact

- **(Preservation over Conservation)**

A Rough Chronology

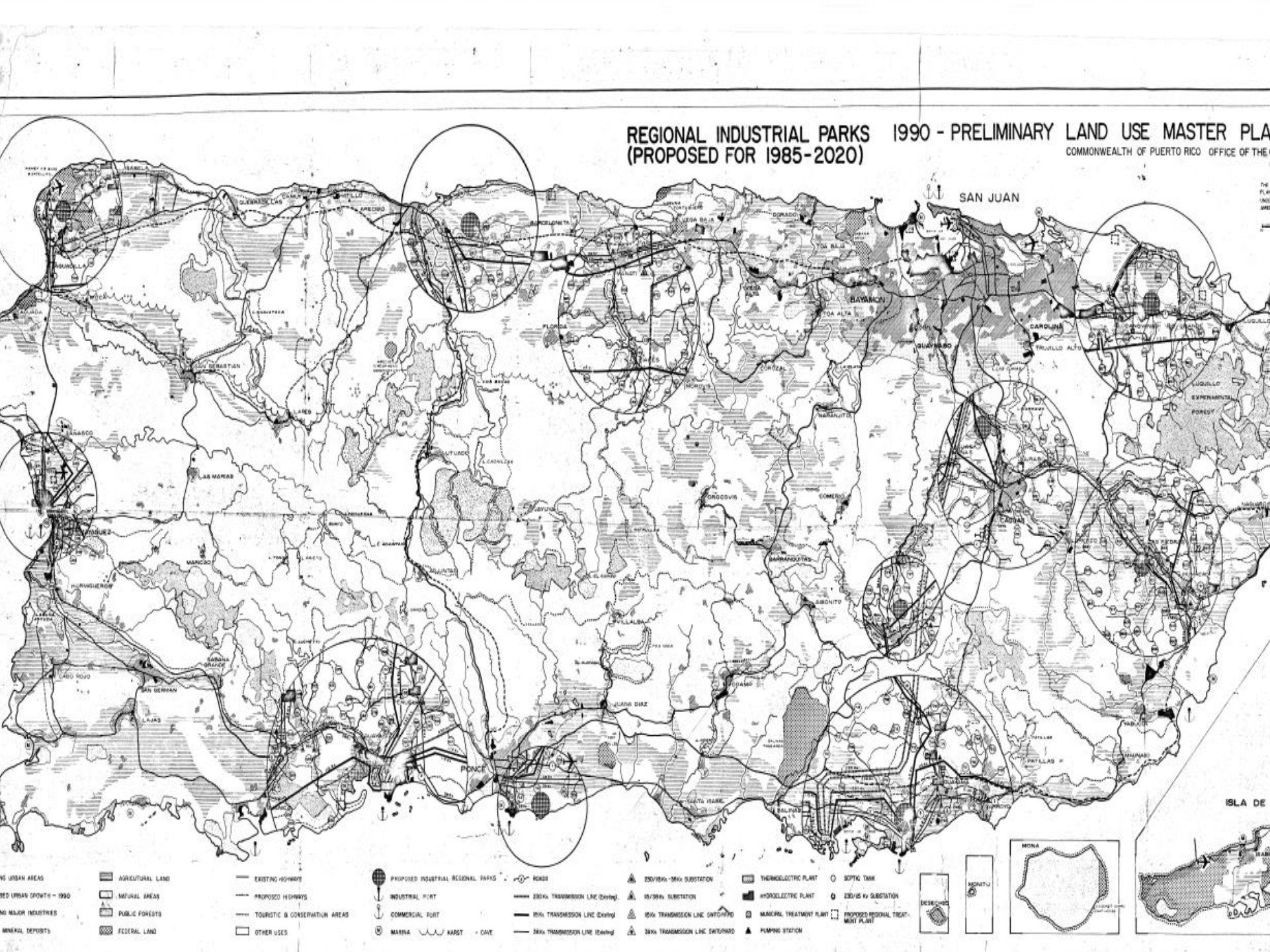
- The Curious Case of the Puerto Rico Copper Mines
  - Phase one: 1950s, 60s, and 70s (Kennecott and Amax projects debated and rejected
  - 1990-1994: Southern Gold project rejected. Set aside as **Bosque del Pueblo**
- No al la Planta de Carbon
  - Debated until tabled after 1992 election
- Windmar
  - First proposed in 2009; opposed due to proximity to **Bosque Seco de Guanica**
- Gasoductos de Sur and Via Verde
  - 2008-2011
- Aspenall and Pattern Windfarms
  - Debated but accepted and went online in 2012

Paradigm of Technology Choice as signal event

1. Developed by industry-government coalition
   - Plan 2020: Development plan for Puerto Rico designed by industry along with Federal, and PR governments.
2. Meets with little initial opposition
   - But opposition grows as awareness of plan disseminates
3. Opposition grows as Ethical Issues are articulated
   - **Social justice**
   - **Consent and Participation**
   - **Appropriateness**
   - **Environmental Impact**
4. Sharp debate between proponents and opponents
   - **Proponents**: other side is politically motivated
   - **Opponents**: other side seeks to maintain power and economic advantage
5. Technology rejected

Signal Event: Copper Mines

Criteria	Copper Mine Case
Project developed by industry-government coalition	Plan 2020 zones center of PR for mineral exploitation. Kennecott and Amax introduce first mining proposals after expensive explorative drilling. Southern Gold Resources introduces project in early 1990s
No preliminary opposition	Projects initially fast-tracked for government approval
Opposition takes on ethical voice	Taller de Artes y Cultura (later Casa Pueblo) generates grass roots opposition through participative stratiges. City Assembly of Utuado holds public hearings on impact of SGR project
Sharp debate between proponents and opponents (two discourses)	**Strong concerns expressed that companies more interested in gold than copper. Environmental concerns about disposal of tailings. Discussion of impact on local farmers and difficulty of obtaining their participative consent**
Technology Rejected	Mining proposals rejected. Bosque del Pueblo locks land use into preservation.


REGIONAL INDUSTRIAL PARKS
(PROPOSED FOR 1985-2020)
1990 - PRELIMINARY LAND USE MASTER PLA
COMMONWEALTH OF PUERTO RICO OFFICE OF THE
SAN JUAN
BAYAMON
CAGUAS
GUAYNABO
CAROLINA
TRUJILLO ALTO
LUQUILLO EXPERIMENTAL FOREST
ARECIBO
BARCELONETA
MANATI
VEGA BAJA
DORADO
TOA BAJA
TOA ALTA
FLORIDA
UTUADO
JAYUYA
OROCOVIS
COMERIO
NARANJITO
AGUADILLA
AGUADA
MOCA
ISABELA
QUEBRADILLAS
CAMUY
HATILLO
LARES
SAN SEBASTIAN
LAS MARIAS
MAYAGUEZ
HORMIGUEROS
MARICAO
ANASCO
CABO ROJO
SABANA GRANDE
SAN GERMAN
LAJAS
GUAYANILLA
PENUELAS
PONCE
JUANA DIAZ
VILLALBA
BARRANQUITAS
AIBONITO
ISLA DE
MONA
DESECHEO
MONITO
AGRICULTURAL LAND
NATURAL AREAS
PUBLIC FORESTS
FEDERAL LAND
EXISTING HIGHWAYS
PROPOSED HIGHWAYS
TOURISTIC & CONSERVATION AREAS
OTHER USES
PROPOSED INDUSTRIAL REGIONAL PARKS
INDUSTRIAL PORT
COMMERCIAL PORT
MARINA
KARST
CAVE
ROADS
230 Kv TRANSMISSION LINE (Exist'g)
115Kv TRANSMISSION LINE (Exist'g)
38Kv TRANSMISSION LINE (Exist'g)
230/115Kv-38Kv SUBSTATION
115/38Kv SUBSTATION
115Kv TRANSMISSION LINE SWITCHYARD
38Kv TRANSMISSION LINE SWITCHYARD
THERMOELECTRIC PLANT
HYDROELECTRIC PLANT
MUNICIPAL TREATMENT PLANT
PUMPING STATION
SEPTIC TANK
230/115 Kv SUBSTATION
PROPOSED REGIONAL TREATMENT PLANT

ACEPTACIÓ N SÓCIÓPÓLITICA A LÓS PRÓYECTÓS EÓ LICÓS PRÓPUESTÓS PARA SANTA ISABEL, P.R

"Este proyecto de renovables es más bien un proyecto de privatización de lo que es nuestro… de lo que es gratis. Es una manera de privatizar algo que esta disponible a todos: la luz, el aire, la fuerza del viento, las olas del mar… Es un proyecto capitalista y eso en si jamás va a ser sustentable por que uno ve que el fin es centralizar las ganancias y distribuir los costos. Los costos se distribuyen entre las comunidades cercanas. Me refiero a los costos no mitigables como el parpadeo de sombras. El costo de tener que dejar de sembrar, eso se distribuye a la nación completa. Si hay terrenos que ya están impactados, vamos a hacer proyectos de energía renovable ahí pero con participación comunitaria. Aquí una personas sin necesariamente hacer los estudios sin llevar a cabo ese proceso amplio de planificación se sentaron a crear un proyecto fuera de un plan concertado… un proyecto de país."

Advantage: Environmental Justice and Economic Impact Study

The highlights of the economic impact analysis are:

1. The construction phase of the project will generate 341 direct, indirect and induced jobs in the area.
2. The construction phase of the project will produce $12.9 million in direct, indirect and induced salary income.
3. The operational phase of the project will generate $4,140,000 in recurrent direct, indirect and induced business revenue, and over $100,000 in direct, indirect and induced labor income.
4. The project will produce over $800,000 in local tax revenues in the construction phase and a recurrent flow of over $15,000 in taxes during the operational phase.

These are substantial economic benefits, considering that the project is a community-scale venture. In addition, the project would generate valuable externalities in the form of economic and environmental savings from the switch from petroleum to clean renewable energy.

Paradigm is Repeated in Cogentrix Case

Criteria	Cogentrix
Project developed by industry-government coalition	AEE and Cogentrix reach agreement on locating plant in Mayaguez area. Plant sells electricity to AEE and steam to Bumblebee and StarKist tuna-canning plants. Plan designed to stave off energy shortages projected for 2000
No preliminary opposition	Projects initially fast-tracked for government approval as part of economic development plan
Opposition takes on ethical voice	Mayaguezanos Por La Salud y El Ambiente form to organize opposition to plant. MPSA gets EPA to fine StarKist and Bumblebee for violating regulations. Public hearings display local opposition and Cogentrix responses.
Sharp debate between proponents and opponents (two discourses)	**Issues Raised:** • **Consent—project being imposed from above** • **Environmental Concern: the plant will contaminate the air and water** • **Safety: plant is located too close to earthquake fault**
Technology Rejected	Rossello administration proposes relocating plant to Maricao. Cogentrix withdraws proposal.

Paradigm is Repeated with Gas Pipelines

Criteria	Cogentrix
Project developed by industry-government coalition	Pipelines projects developed by AEE to reduce Puerto Rico's dependence on imported oil
No preliminary opposition	Little initial opposition for Gasoductos del Sur as construction begins
Opposition takes on ethical voice	Opposition arises to Gasoductos del Sur because route targets marginalized "urbanizaciones." Residents of central island towns (Utuado and Adjuntas) oppose Via Verde.
Sharp debate between proponents and opponents (two discourses)	**Issues Raised in Adjuntas Public Hearings:** • **Consent—project being imposed from above** • **Environmental Concern: pipeline construction will disrupt fragile and unique central island ecosystems** • **Safety: residents near proposed path concerned about pipeline explosions and cite recent explosion in California** • **Social Justice: Pipeline construction will displace more traditional activities like farming.**
Technology Rejected	Both pipeline projects rejected; a third one is being floated that will transport gas under water

Paradigm is Repeated with Windmills

Criteria	Aspenall and Pattern
Project developed by industry-government coalition	Arguments in study by Advantage assert: •"There is no reason for an environmental justice concern in this project" • "the project will generate significant economic benefits"
No preliminary opposition	In a paper for MPSA, Carlos Delannoy identifies six renewable sources for energy, one of which is wind power. This seems a viable alternative to coal, oil, nuclear, and natural gas.
Opposition takes on ethical voice	Report by Ortiz and Pares distinguishes between external and internal organized opposition. The latter is much more STS-oriented. Stakeholders, mostly opponents, are also organized according to strength of interest and accessible power.
Sharp debate between proponents and opponents	**Opposition Concerns:** **•Lack of consent and participation (surveyors were seen uninvited in backyards)** **•Social injustice based on continuation of colonial policies** **•Control over Environment: windmill farms will crowd out livelihoods based on agriculture**
Windmills go online in 2012	Project accepted and went online two years ago. (Pictures)

A Framework for Technology Choice in Energy

- Zoom in
  - Describe/classify the technology
- Zoom out
  - Describe the socio-technical system
- Back-and-Forth
  - Is the technology “appropriate” to its socio-technical background?
- Social Justice
  - Does the technology expand some capabilities without contracting others

Zooming in to the Artifact

- Classify Artifact
  - Social, Technical, Artistic, Natural
- Describe Structure
  - Materials, Static Structure
  - Synchronic
- Outline Functioning
  - What is the artifact doing when it does what it has been designed to do?
  - Locate artifact in natural, social, technical, economic ecologies
- Identify embedded values (Flanagan et al.)
  - **Values in the definition of a project, values that emerge in specifying instrumental design features, designers' values, user values (including subervision)**

Zooming out to the STS

- Hone in on the different environments that constrain and enable action
- Find sub-environments like…
  - hardware, software, physical surroundings, stakeholders, procedures, laws, information systems
- Visualize the overall system and how its parts are interrelated and interact
- Identify the values embedded in the system…
  - whose conflicts produce internal changes
- Find other STSs with which it interacts and trace value positive and negative trajectories of change

Hardware	Software	People, groups, roles	
Soft Path • Solar • Photo Voltaic • Windmills • Hydroelectric • Hydrogen (electrolysis) Hard Path • Oil • Coal • Nuclear Fissure • Nuclear Fission • Incinerators • Natural Gas **(Shrader-Frechette)**	SoDIS (Software Development Impact Statement—Gotterbarn 2002) Intelligent Power Routers (IPRs)	Government • EPA • JCA • PREPA • DRN	Agricultural Interests • Bamboo • Coffee • Sugar • Plantains • Aquaculture
	HAZUS (software for determining risk of natural hazard) MAEviz (natural hazard think tank at U of I that provides hazard risk software)	Citizen Interest Groups • MPSA • Liga Ecologica • Casa Pueblo	Public • Energy Consumers • NIMBY • Value Issues (Social Justice, Health Safety
	Gardoni, et al. "Capabilities-Based Approach to Measuring the Societal Impacts of Natural and Man-Made Hazards in Risk Analysis" 2009, NATURAL HAZARDS REVIEW © ASCE / MAY 2009 / 30.	Private Industry • Pharmaceutcal • Multinational • Local Industries • Oil Refineries Unions--UTIER	Agricultural Interests • Farmers in Santa Isabella and Guanica Bosque Seco de Guanica

Procedures		Laws / Policies	Rates and Rates Structure
• Energy consumption habits • Market-based energy distribution • Exemptions for poor and eleemosynary groups • Conservation Strategies		• Legislation establishing public utilities (See O'Neill, EthosVI) • Privatization of Public Utilities (Windmar and Cogentrix represent projects sponsored by private utilities to sell energy to AEE)	Archival material on power STS

Distributive Justice
• **Entitlement**
• **Pattern-Based**
  • **market**
  • **need**
  • **merit**
  • **Right**
  • **Equal**
	Power Distribution
	• **High Demand**
	• **Normal Demand**
	• **Low Demand**
	• **During power disruptions**
		• Autoridad de Energia Electrica
		  • Environmental Agencies
		  • Environmental Protection Agency
		  • Junta de Calidad Ambiental
		  • Departamento de Recursos Naturales
		  • OSHA
		• ITEAS (Academic Think Tanks and role of honest broker)
			Data collection procedures for STS study

Appropriate Technology • **Decentralized** • **compatible with laws of ecology** • **makes use of modern knowledge** • **gentle in the use of resources** • **serves the human person** • **production by the masses**		Civil Law • Eminent Domain (Issues in Windmills, Gasoductos, CORCO, and Via Verde) • Property Rules • Injunctive Relief against pollution (living near Catano and CORCO) • Liability Rules	Data collection for market analysis (hypotherical versus actual markets and preferences plotted into price)

Capability Approach
• **Life, Bodily Health, Bodily Integrity**
• **Sense/Imagination/Thought, Emotion, Practical Reason**
• **Affiliation, Other Species**
• **Control over Environment, Play**
		Public Hearing Process (and public participation in permit process)
		• Windmar hearings held in Rio Grande
		• Secrecy in Santa Isabella projects
		• Cogentrix public hearings (damage to coral reefs and manatee)
		• Adjuntas Public Hearings (Health, Ecological, Social testimonies)
			• Free and informed consent (IRB issues associated with Data Collection)
			• Risk Policy
			  • Risk Assessment
			  • Risk Perception
			  • Risk Commination
			  • Risk Management (NIMBY or Social Justice?)

Back-and-Forth: Appropriateness

- Willoughby
  - "An appropriate technology is defined here as a technology tailored to fit the psychosocial and biophysical context prevailing in a particular location and period." 19
  - "The inappropriateness of technology may stem from its being deployed in a context quite different to that for which it was designed, or it might be manifested in the harmful effects of technology upon one class of people despite its appropriateness from the point of view of another class of people." **Technology Choice, 5-6**

Zooming back and forth

- Decentralized
- Simple
  - Not tightly coupled and largely linear
- Gentle in its use of resources
- Labor Intensive
  - Builds skills, strengthens capabilities (combined capabilities)
- Low cost and low maintenance
- Bottom Line: enhances the capability of control over environment

Appropriate Technology Matrix

AT criterion / Energy STS	Oil	Wind Turbines
Simplicity	Complex, decaying, obsolete	Simple or intermediate. **(Coupling in El Hierro project)**
Decentralization	Highly centralized from production to distribution	Centralized model in PR but can be decentralized
Labor Intensive	Cleaning up would be labor intensive but actual operation does very little for local employment	Largely automated. Construction , operation, and maintenance are specialized. **(Consider operation on El Hierro)**
Gentle in use of resources	Wasteful producing areas full of toxic wastes	Compared to Oil, yes.
Serves people (and not other way around)	Serves oil interests (or at least this is widely held public belief) Corruption concerns	**Flickering Crowding out subsistence farming. Kills birds & bats. Micro climate changes?**
Low cost / Low maintenance	High cost and high maintenance based on using out of date technology and facilities	**Advantage**: economic advantages **Oritiz Rept**: Problems with political and econ participation and freedoms

Looking at Social Justice

- Not focused on distribution and consumption of goods but on "substantive freedoms" or "beings and doings"
- CA focuses on taking away elements of the STS that impede freedom and choice in these "zones" of choice

Nussbaum's Capabilities

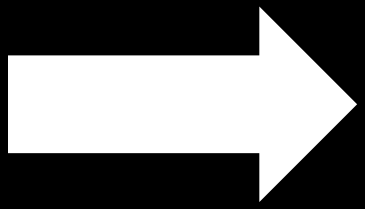
- **Life, Bodily Health, Bodily Integrity**
- **Sensation/Thought/Imagination**
- **Emotion, Practical Reason,**
- **Affiliation, Other Species,**
- **Control Over Environment, Play**

1. Refine internal capabilities through education
2. Identify risks, i.e., features of surrroundings that block functionings

Capabilities Approach fleshes out social justice

- Realizing minimum threshold of human dignity
  - "dignity," "respect," "rights," and "freedom," form a system of concepts that give meaning to one another
- Reconfiguring risk as reducing choice and freedom
- Responding to injustice through repair and reconciliation
  - Displacing viable traditions (subsistance farming)
  - Destruction of social relations through deliterious effects of colonialism and imperialism
  - Unfair distribution of money and wealth through irresponsible financial speculation

Energy as Conversion Factor

Capabilities  Functionings

Burning Wood/Charcoal

Capabilities

- *Health*
- *Control Environment*

Burning

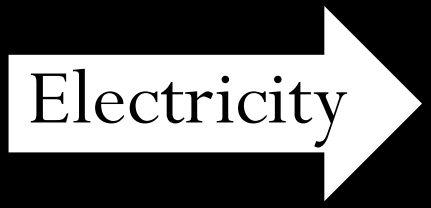
Functionings

- *Cooking (+), Respiration (-)*
- *Deforestation (-)*

Electricity

Capabilities

- *Health*
- *Thought*
- *Affiliation*
- *Play*



Functionings

- *Medical tools*
- *Reading, Computing*
- *Evening meetings*
- *Amplified music*

The ***selection*** of generation means is further informed by

- principles of Appropriate Technology
- accounting for underlying Socio-Technical System

all of which requires community dialogue and partnership

Capabilities Matrix

Capability at risk	From Oil (includes actual harms)	From Wind Turbines
Bodily Health	Respiratory ailments in Catano Unsafe storage practices lead to CAPECO explosion	Displacing agricultural activities expands dependencies on imported food which is less healthy and vulnerable to off island shortages
Bodily Integrity (transportation)	Transportation fueled by oil (Unstable supply)	Wind can power boats (sails) but little land use other than recreational
Practical Reasoning	Difficulty of long term planning given instability of oil market and risk of environmental harm.	Wind farms crowd out traditional farming" practices which creates unemployment. (Problems of finding the right location)
Other Species	Producing and consuming oil contributes to global warming.	Parpadeo de sombras or shadow flickering; birds and bats killed by rotating blades
Control Over Environment	Volatile market could make electricity unaffordable	Advantage Report: economic Oritiz Rept: Risk to economic and political participation

A Framework for Energy Approaches

Four Modules	Techno-socio Sensitivity	Framework to practice skill of techno-socio sensitivity	Activities
Socio-Technical Systems in Professional Decision Making (m14025 from Connexions®) Responsible Choice For Appropriate Technology (m43922) Writing and Analyzing Ethics Cases (m15991) Capability Approach (m47654)	"critical awareness of the way technology affects society and the way social forces in turn affect the evolution of technology" CE Harris, (2008), "The good engineer: Giving virtue its due in engineering ethics," Science and Engineering Ethics, 14(2): 153-164.	1. Zoom in to artifact • Structure • Classify • Function 2. Zoom out to STS • Describe sub-environments • Integrate sub-environments into system 3. Back-and-Forth with Appropriateness • Decentralized, compatible with laws of ecology, makes use of modern knowledge, gentle in the use of resources, serves the human person, production by the masses 4. Approaching Social Justice through Capabilities • Bodily Integrity, Education, Practical Reason, Other Species, Control Over Environment	• Students classify artifact • Student groups present case through poster Poster includes • Capabilities Matrix • Appropriate Technology Matrix • Socio-Technical System Table Graduate students publish case studies based on AT research in Connexions® • Cases shared with undergraduates

Thanks to…

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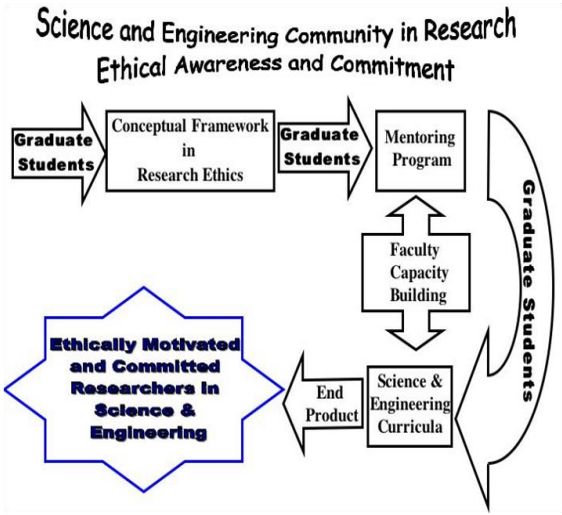
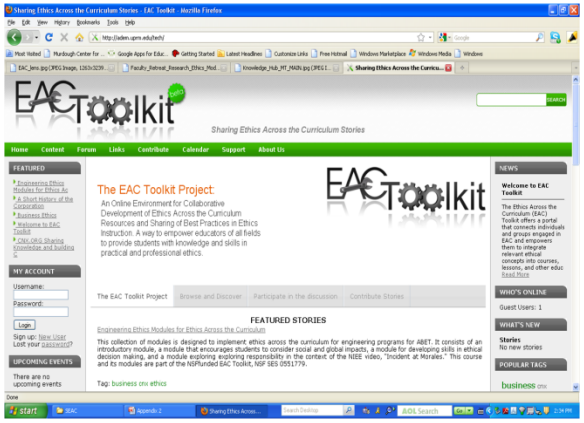
THANK-YOU

WILLIAM J. FREY, COLLEGE OF BUSINESS ADMINISTRATION, UNIVERSITY OF PUERTO RICO AT MAYAGUEZ





EAC Toolkit

- Value Profile: Responsibility
  - **http://cnx.org/content/m44683/latest/**
- Responsible Research in Appropriate Technology
  - **http://cnx.org/content/col11556/latest/**
- The Environments of the Organization
  - **http://cnx.org/content/col11447/latest/**
- Capability Approach
  - **http://cnx.org/content/m47654/latest/**
- Responsible Choice for Appropriate Technology
  - **http://cnx.org.content/43922/latest/**