Evaluating Infrastructure Investments:
An Economic Regulatory Perspective

Government-University-Industry Research Roundtable (GUIRR)
Infrastructure: The Cost of Doing Nothing
June 25, 2013, The National Academies, Washington, DC

Institute of Public Utilities ▪ MICHIGAN STATE UNIVERSITY
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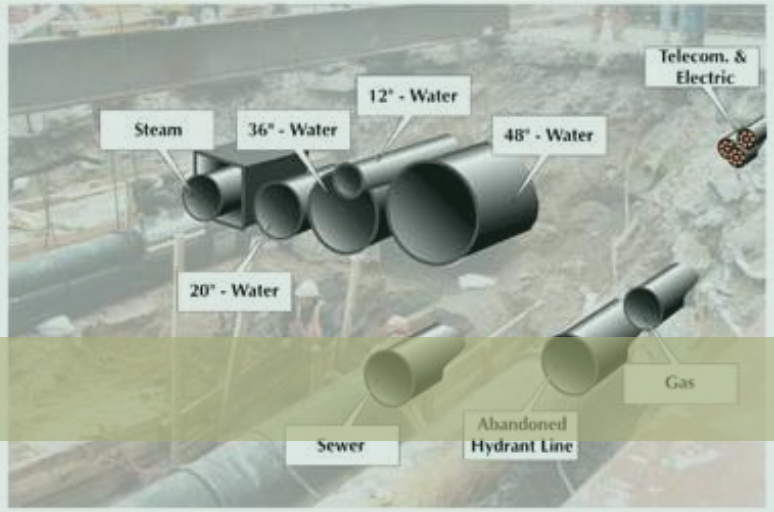

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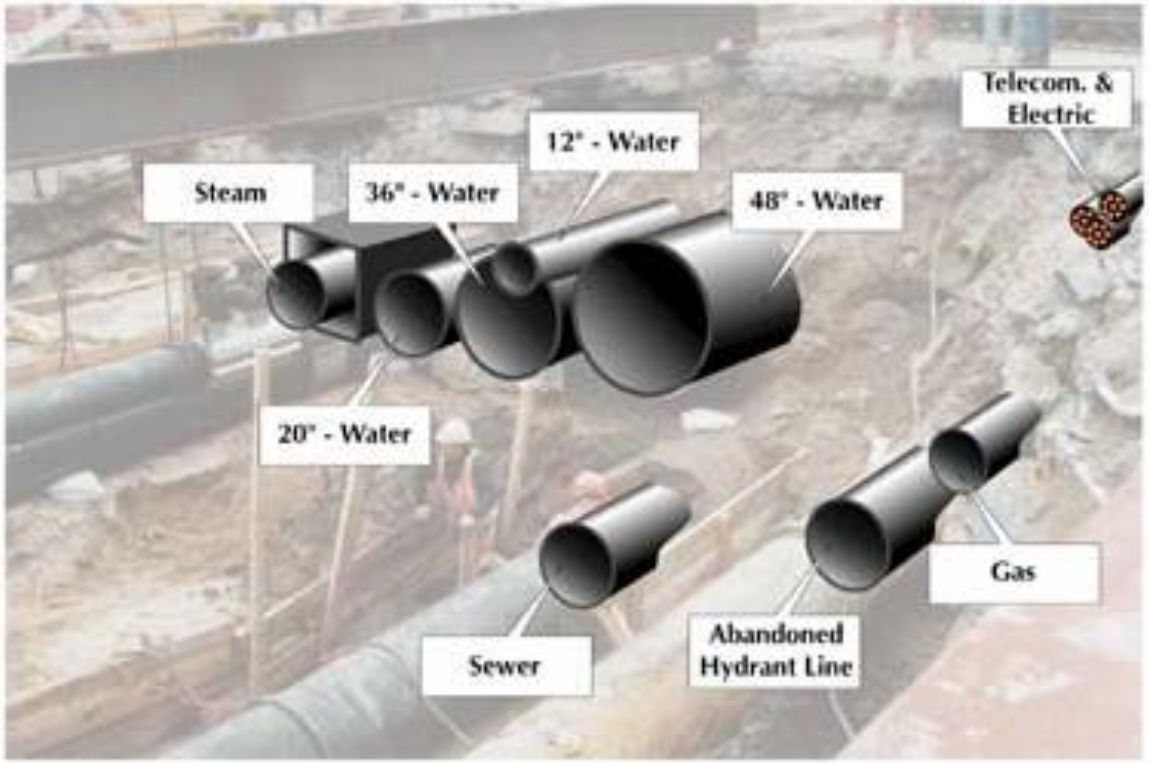
The Institute of Public Utilities

IPU MSU

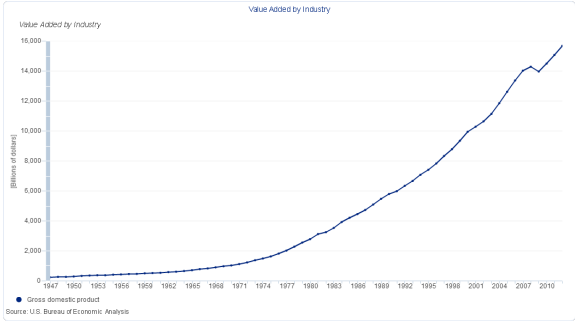
- IPU-MSU has served the regulatory policy community since 1965
  - Mission: To support informed, effective, and efficient regulation of the electricity, natural gas, telecommunications, and water industries
  - Support from the regulatory policy community
  - Professional education for more than 20,000 regulators
- Neutral and integrative educational programs and research
  - A principled approach to regulatory practice
  - An empirical approach to regulatory analysis
  - A reasoned approach to structural and regulatory change
- We teach the “ideal” of regulation *in the public interest*
  - Regulation as a “balancing act” between utility investors and ratepayers

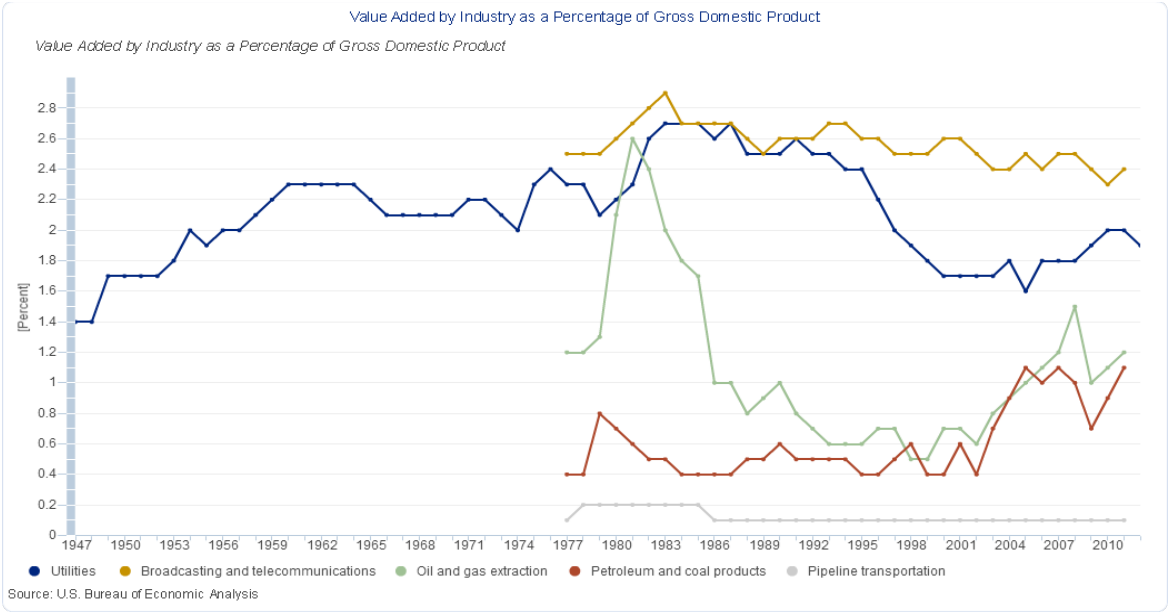
Public utilities as “invisible networks”



Public utilities in the U.S. economy: 2% of GDP

- Most utilities are dominated by private ownership – water is the exception
- Revenues (2007 Census)
  - Electricity generation: $440 bil.
  - Electricity distribution: $306 bil.
  - Wired telecom: $294 bil.
  - Wireless telecom: $168 bil.
  - Gas distribution: $132 bil.
  - Water: $9 bil.
  - Electricity transmission: $4 bil.





What “good” are utilities?

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Public institutions:
Collective interests; limited discretion; human rights; access; positive externalities

		Feasibility of cost allocation [exclusivity; divisibility; priceability	
		Lower	Higher
Marginal impact of production or consumption [rivalry; depreciability; exhaustibility]	Lower	**Public goods** or collective, merit, or worthy goods	**Toll goods, club goods, infrastructure, utilities, and network services**
	Higher	**Common-property** or common-pool goods or resources	**Private goods** for individual consumption

Market institutions:
Individual interests; consumer discretion; property rights; congestion; negative externalities

Utility infrastructure inventory

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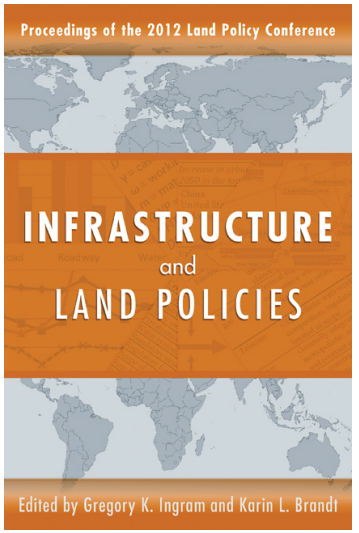
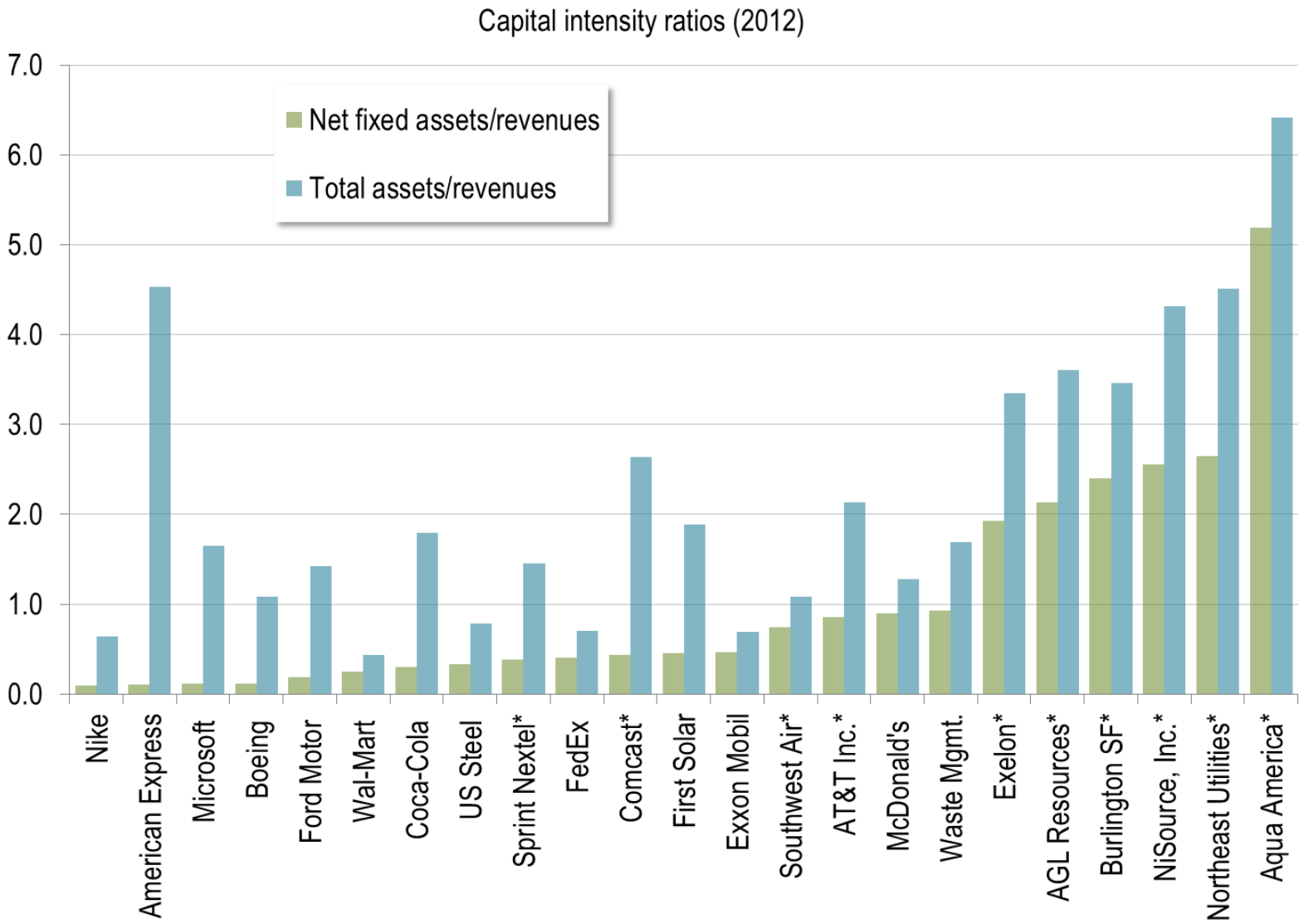
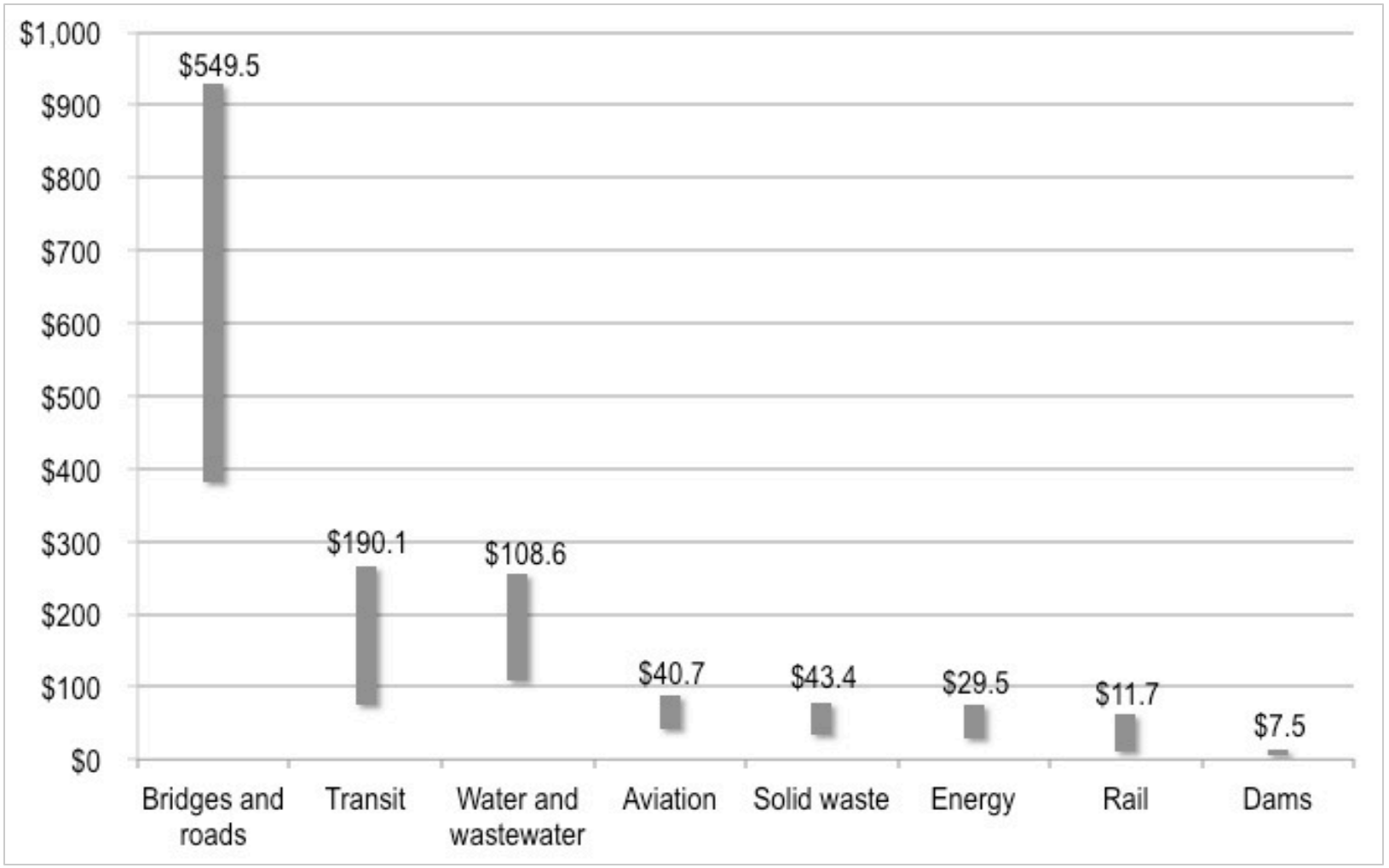
- 66 nuclear, 580 coal, 1,169 petroleum, and 1,705 natural and other gas plants
- 1,432 hydroelectric and 39 pumped storage facilities
- 1,356 renewable energy facilities (non-hydro)
- 395,000 miles of high-voltage (>100 kV) transmission lines
- 15,700 transmission substations
- 6.0 million miles of electricity distribution lines
- 20,000 miles of gas gathering pipelines
- 306,000 miles of interstate and intrastate transmission pipelines.
- 1,400 gas compressor stations
- 400 underground natural gas storage facilities
- 2.0 million miles of gas distribution mains
- 75,000 water treatment facilities
- 2.0 million miles of water distribution mains (half are 6 to 10 inches in diameter)
- 14,500 wastewater treatment facilities
- 600,000 miles of wastewater collection lines
- 18.7 million equivalent telephone poles
- 1.7 billion miles of metallic wire
- 38 million miles of fiber wire



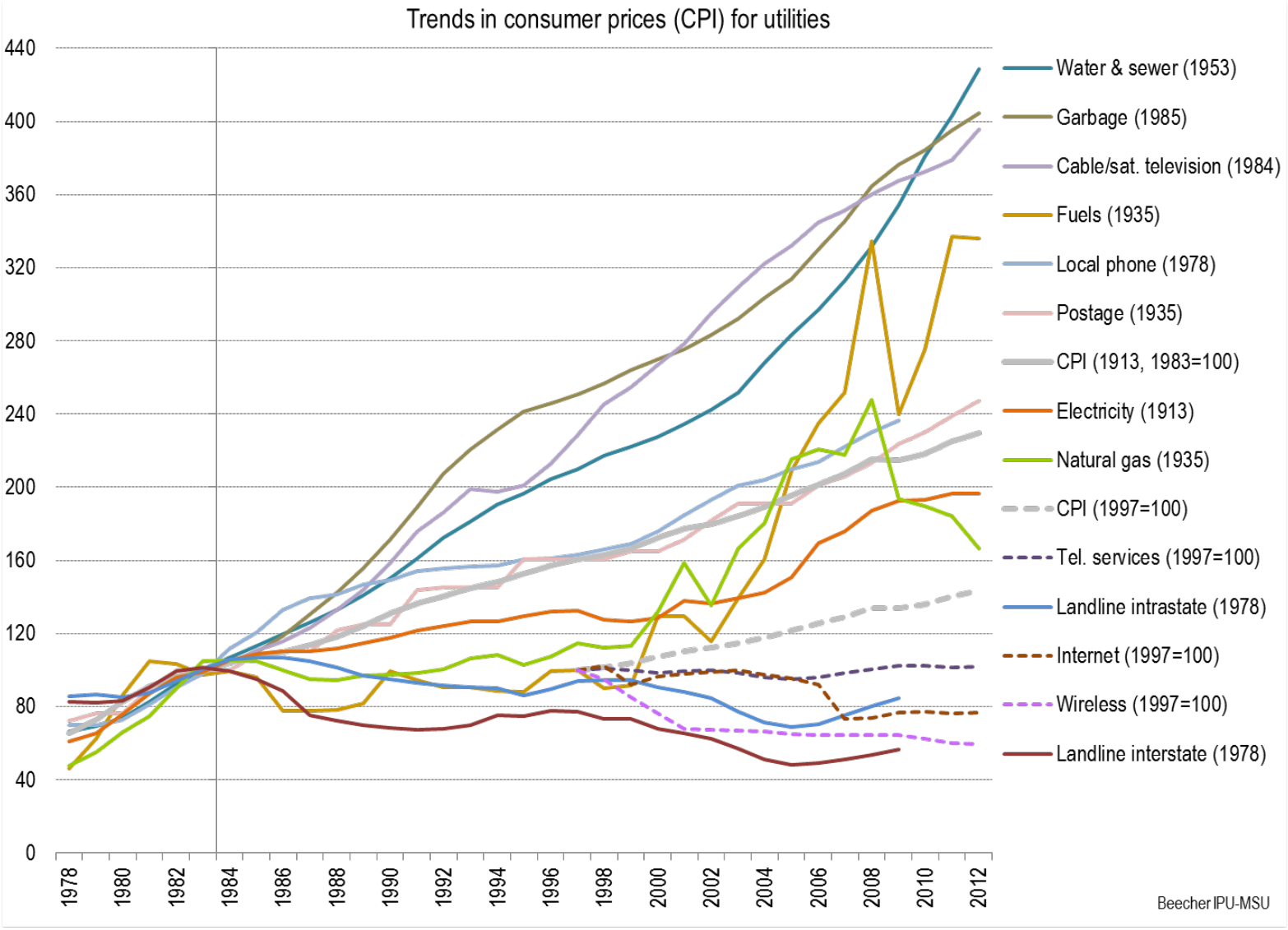
Technical traits of utilities: comparing capital intensity



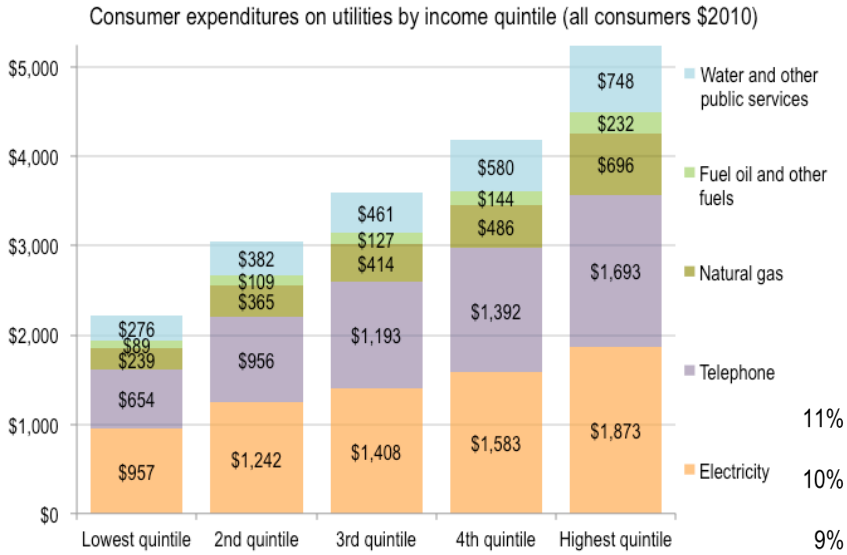
Estimated 5-year funding needs ($bil., ASCE)

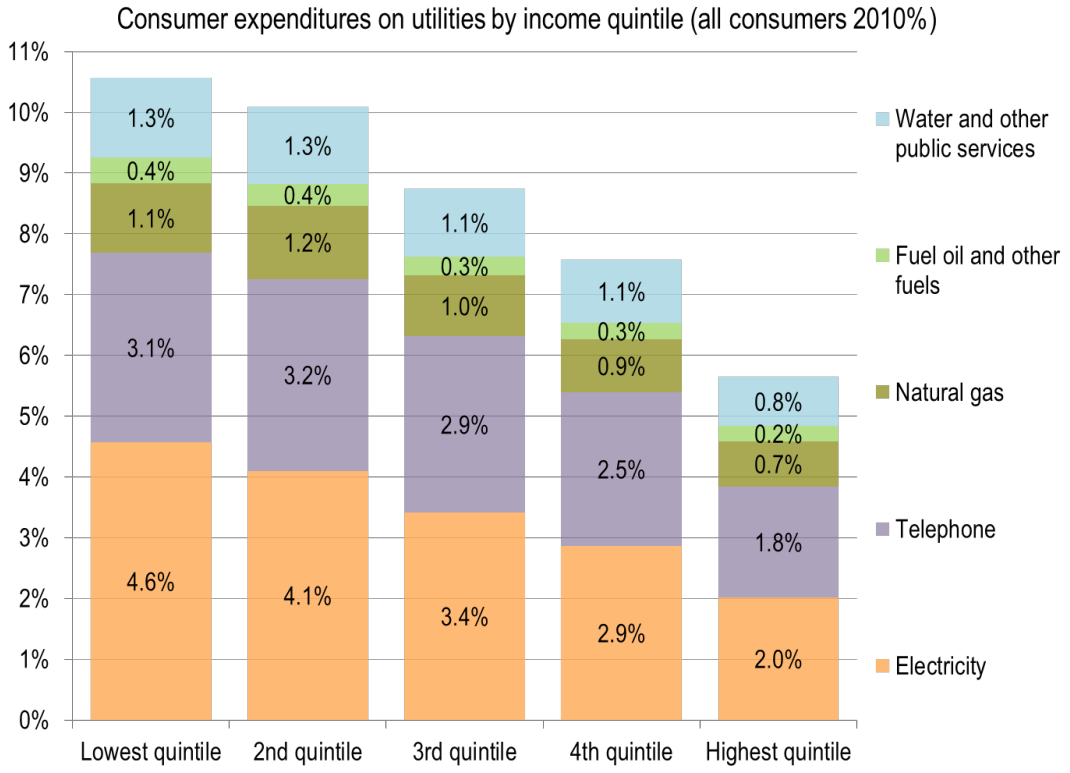


CPI trends for utilities (U.S.)

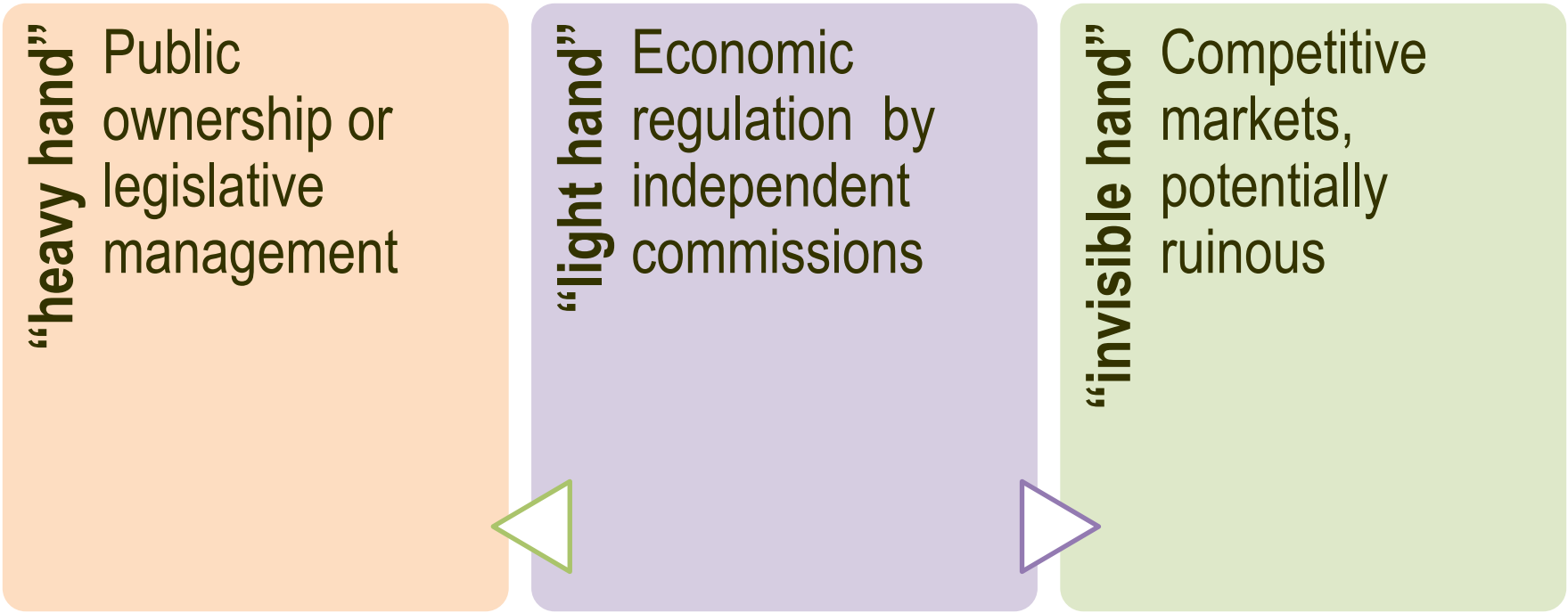


Utilities expenditures by income level and regressivity





Economic regulation as historical political compromise



National Civic Federation (1907):
"Public utilities are so constituted that it is impossible for them to be regulated by competition… None of us is in favor of leaving them to their own will, and the question is whether it is better to regulate or to operate."

Commission policymaking roles

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Commissions as agencies of the state

Quasi-legislative: Trustee	Quasi-administrative Expert	Quasi-judicial: Judge*
Commissions make policy like a legislature; rulemaking and standards development; controversial as to authority, discretion, and policy activism	Commissions apply expertise like a bureaucratic agency; implementation and enforcement; controversial as to effectiveness and efficiency	Commissions deliberate and make decisions like a specialized court; procedural due process, impartiality, judicial demeanor; controversial as to conflicts of interest

Structural and regulatory status of the sectors

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	Structural status	Unregulated	Regulated
Electricity	Partial restructuring and wholesale competition with mixed results; some retail choice	Independent power generation; most nonprivate utilities	Interstate and unbundled transmission (federal); retail distribution (state); vertically integrated (shared)
Natural gas	Vertical segregation with competitive wholesale markets; some retail choice	Wellhead (commodity) gas production; most nonprivate utilities	Interstate transmission (federal); intrastate trans-mission and retail distribution (state); pipeline safety (shared)
Telecom	Oligopolistic with workable competition; regulation is limited in scope	Long-distance, wireless, internet, and cable services; other services and equipment	Small independent providers (state); network access and universal service (shared)
Water	Generally integrated and monopolistic; some wholesale and contract activity	Most nonprivate utilities; most privatization contracts; most wastewater providers	All privately owned utilities and some nonprivate utilities (state only)

The regulatory paradigm

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Economic regulation *serves the public interest*

Premised on	*Manifested in the*	*Stewarded by*
Market failure	Regulatory compact	Independent regulators

The regulatory institution *substitutes for competition*

Principles	Processes	Policies

Regulation's functional model *motivates desired performance*

Standards	Accountability	Incentives

Utility rights and obligations under the regulatory compact

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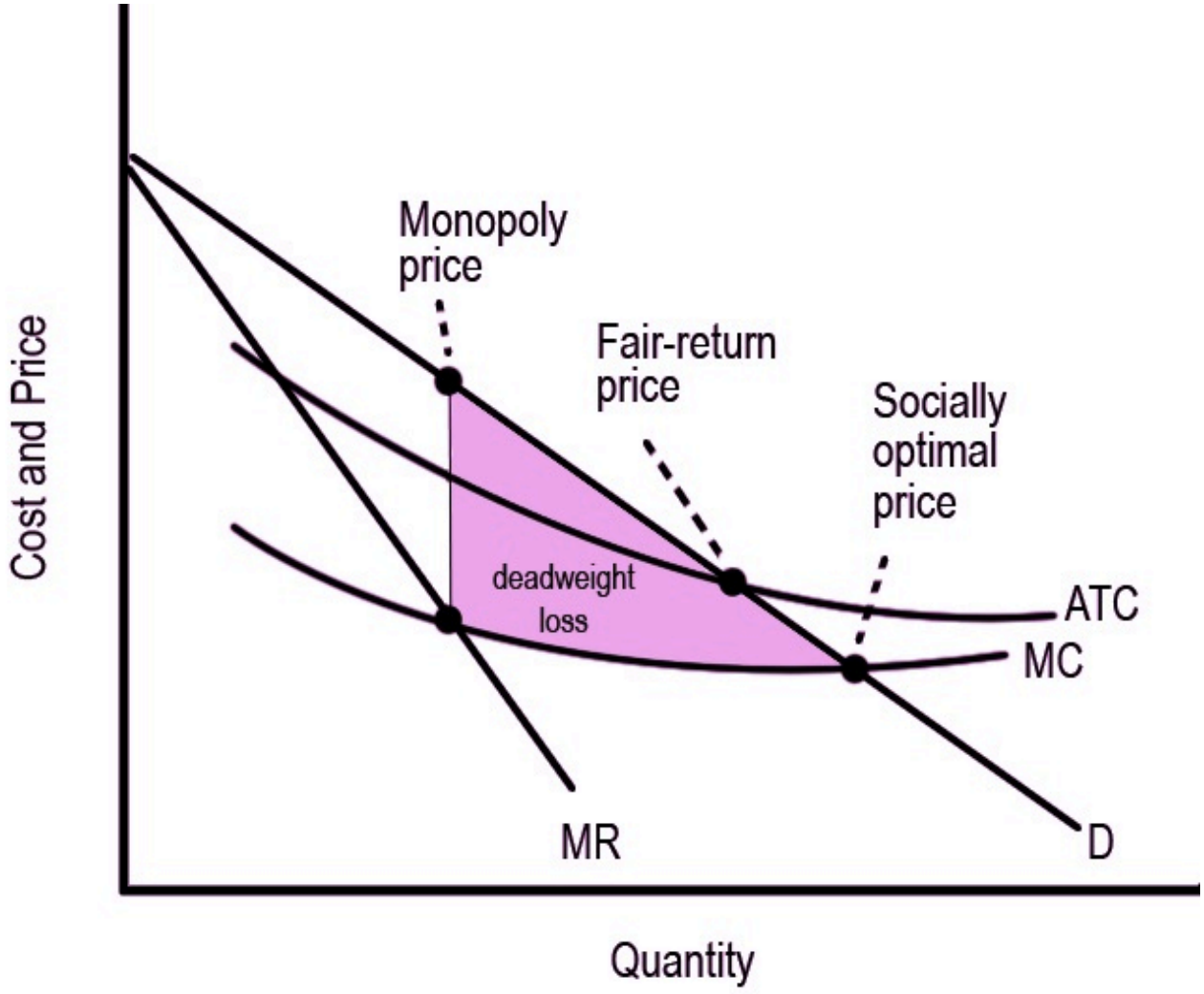
Rights: The utility enjoys

- An exclusive franchise for a certificated service territory, protection from competition and antitrust, an opportunity to recover prudently incurred costs including a reasonable return on investment, rights of eminent domain, and the ability to charge customers for the cost of service

Obligations: The utility accepts

- An obligation to provide all paying customers with safe, adequate, reliable, and nondiscriminatory service on just and reasonable terms, while assuming certain business risks and subjecting itself to regulatory oversight of prudence, prices, profits, and performance

Regulators must establish a “fair-return price”



$$RR = r(RB) + O\&M + D + T$$

Prudent?
Used and useful?
Just and reasonable?
Compensatory?

where:

RR	=	annualized revenue requirements
r	=	authorized (not guaranteed) rate of return to compensate debt holders and equity shareholders
RB	=	ratebase (original cost of utility plant in service net of accumulated depreciation and adjustments)
O&M	=	operation & maintenance expense
D	=	depreciation expense
T	=	taxes

Revenue requirements (RR)
Billing determinants (usage) = Cost-based rates

Standards of regulatory review*

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- Economic regulation is justified by the *public interest*
- Regulation ensures that service is *safe, adequate, reliable, and accessible*
- Utility investments and expenditures must be *prudent*
- Utility investments and expenditures must be *used and useful* to ratepayers
- Returns must be *compensatory but not excessive*
- Rates charged by utilities must be *just and reasonable*
- Regulated returns are authorized but *not guaranteed*
- Regulated utilities are not shielded from *business risks*

**Tested through a long history of Supreme Court decisions*

Regulation and incentives

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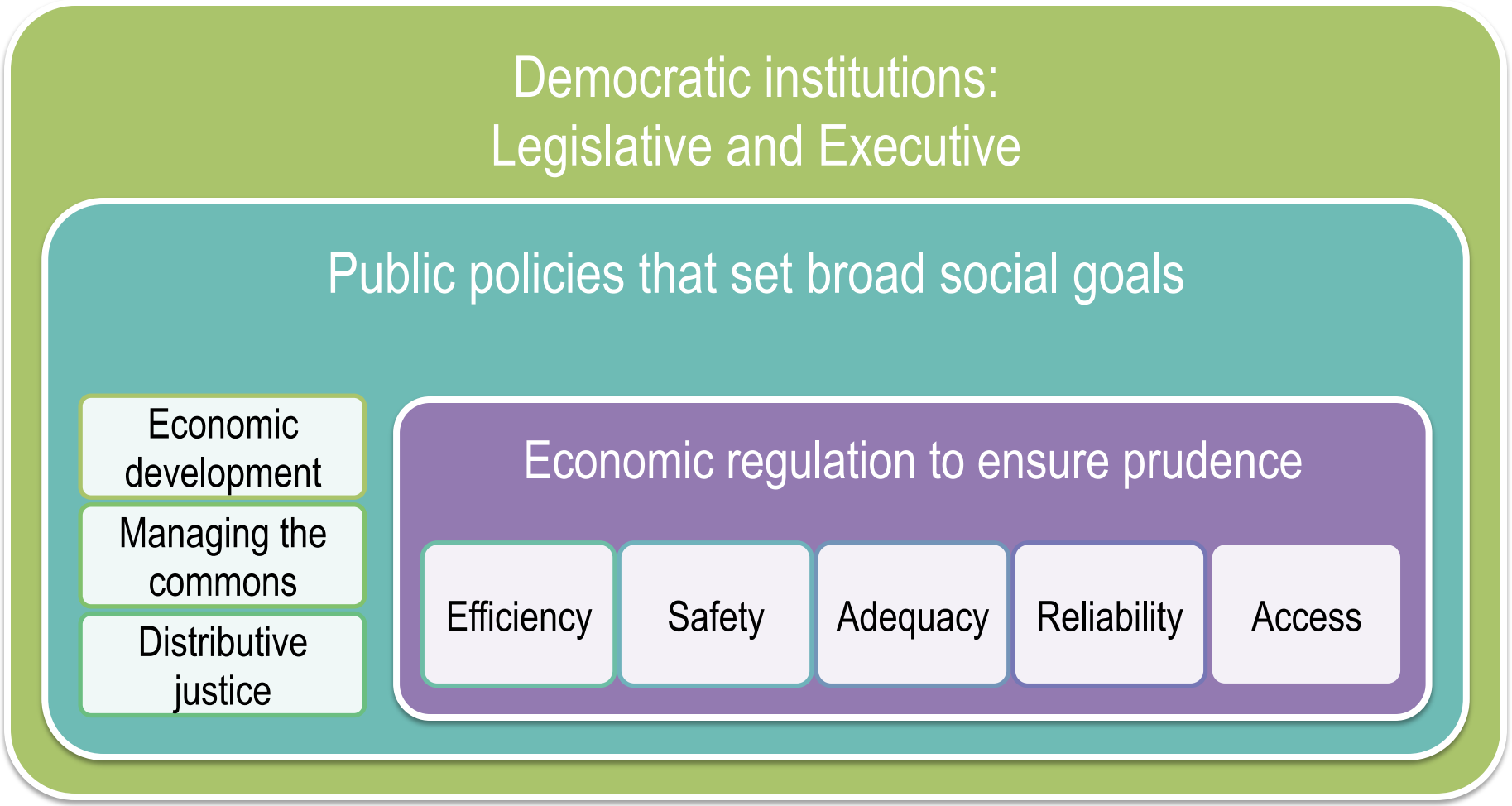
- Privatization is not competition - market power must be addressed
  - Private utilities are strongly motivated to invest – compare to publicly owned
  - Regulators do not (micro)manage utilities – substituting for competition, they must provide incentives for efficiency and innovation
- All regulation is incentive regulation (A. Kahn) – to shape performance
  - Utilities will respond to the incentives and disincentives provided
- Three essential incentive tools impose discipline or "regulatory risk"
  - Regulatory lag – passive
  - Prudence review – reactive
  - Incentive returns – active (and should be used sparingly)

Regulation's institutional role in achieving social goals



Does infrastructure modernization demand new paradigms?

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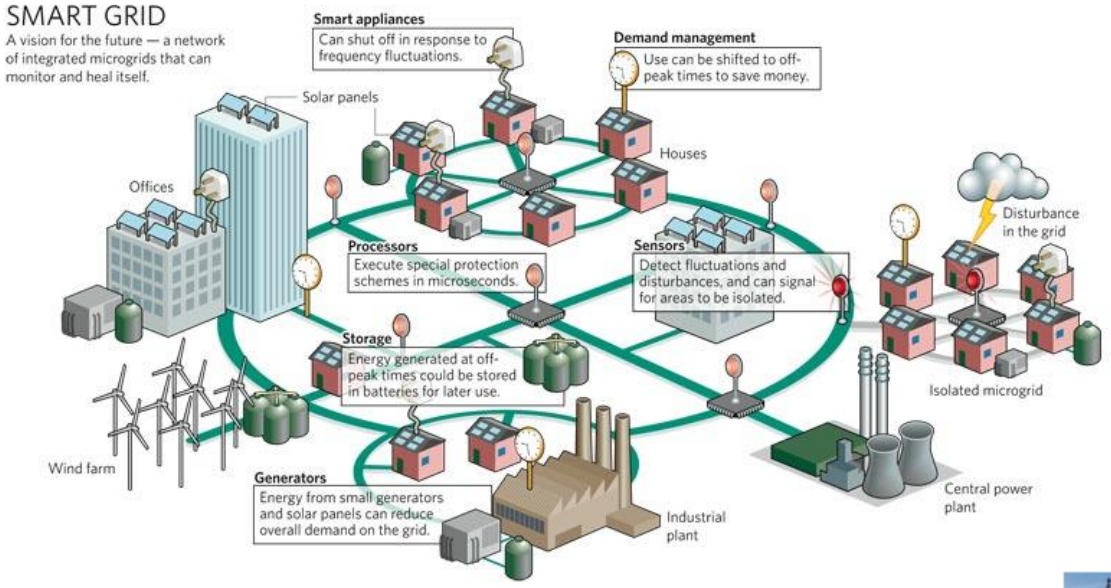
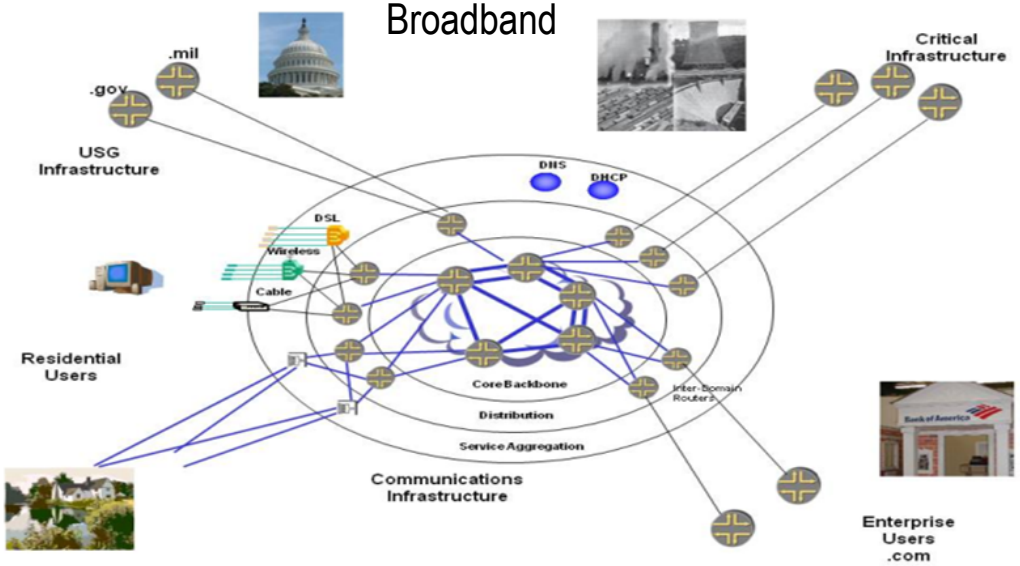


Broadband



Issues of scale are pervasive across the utility sectors

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UTILITY SCALE		Structural		
		Larger scale	Smaller scale	Individual (nonutility)
Technological	Larger scale	Super-grid utilities with lumpy capacities	Networked providers	
	Smaller scale	Distributed production	Micro-grid utilities with flexible capacities	
	Granular scale			END USER

Disruptive technologies as game changers

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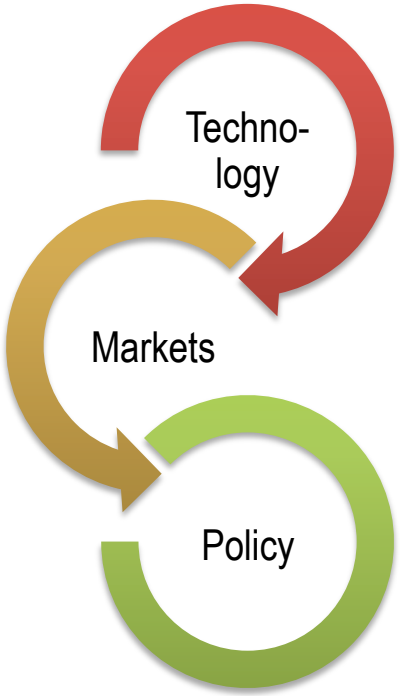
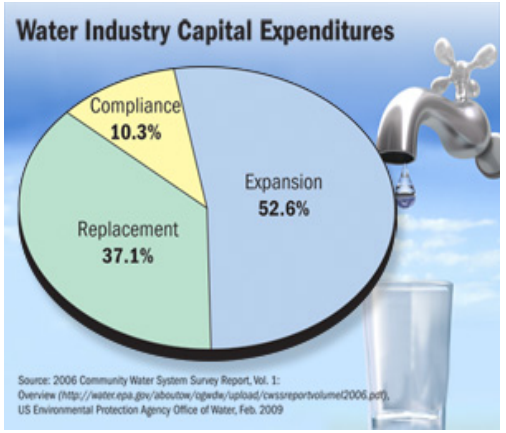
- Disruptive technologies challenge assumptions about scale and optimization
  - Distributed production, energy storage, micro-grids, fuel cells, etc.
  - Potential benefits of smaller scale: reliability, security, resilience, environmental protection, technical innovation
  - Climate change suggests technical and policy urgency
  - Sector-specific considerations: energy is not telecom, water is not energy, etc.
- Key technical and structural questions
  - Can service be provided without *network infrastructure?*
  - Can service be provided without *public utilities?*
- Key policy question
  - Do persistent market failures (monopoly or other) call for continued economic regulation?



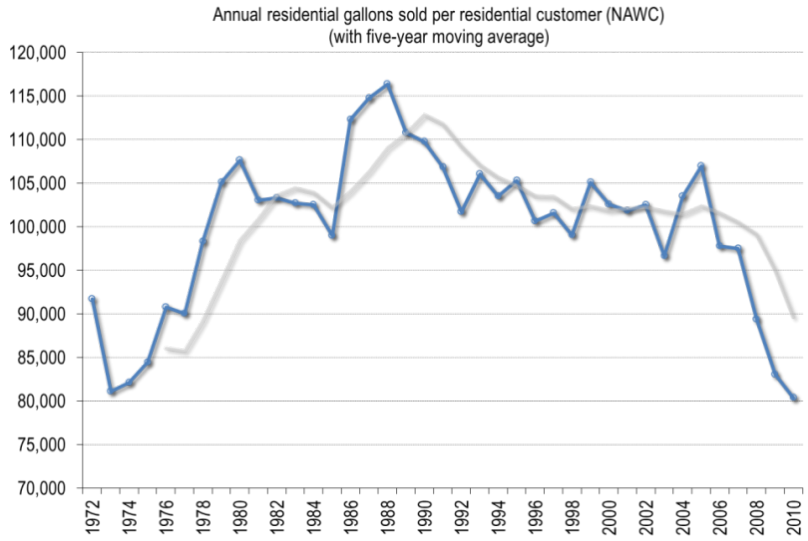
The potential cost of doing "too much"

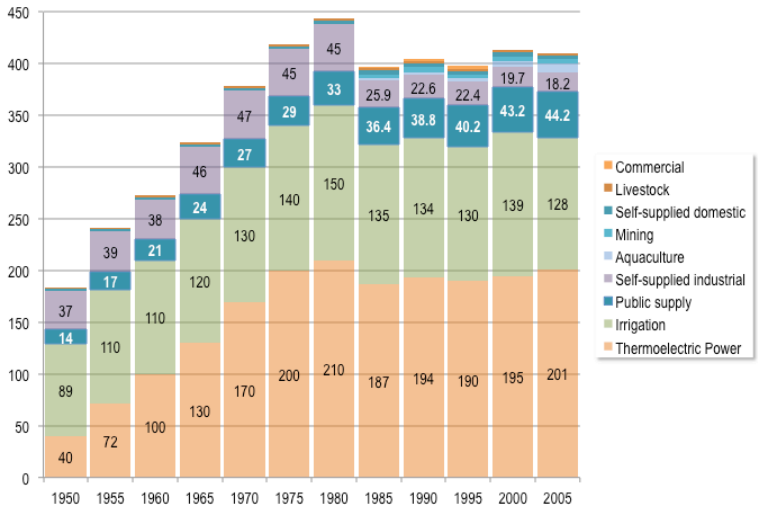
- Do not build *tomorrow's* infrastructure according to *yesterday's* demand and supply specifications
  - Limitations of static surveys of needs - revisiting the assumptions (in-kind replacement, expansion, etc.)
  - Infrastructure as dynamic and complex systems (supply and demand)
  - Opportunities for optimization and strategic asset management
- Infrastructure spending gap as a *construct*
  - Close from the top (demand-side and supply-side efficiency)
  - Close from the bottom (cost-based pricing)
- Toward a new paradigm
  - From growth to sustainability



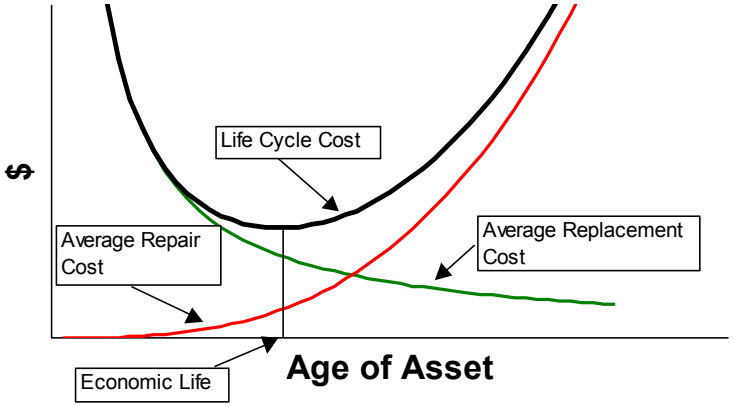
New normals in water usage

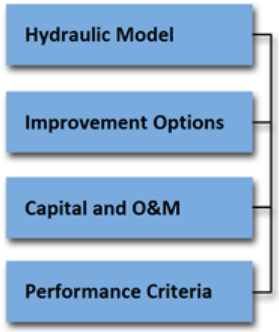
- In the U.S., public supply accounts for only one third of withdrawals for either irrigation or thermoelectric cooling
- Water withdrawals are relatively flat and household water usage has declined
  - Multiple causes (standards, price, culture)
  - Increasing pressure prices
  - Especially problematic for “shrinking cities”
- Opportunities for reoptimization
  - Preemptive replacement v. “run to fail”

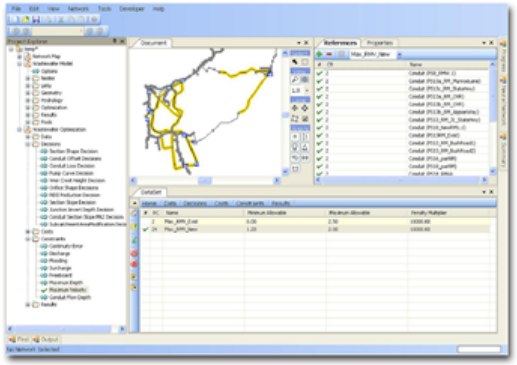




Genetic algorithm optimization (water)





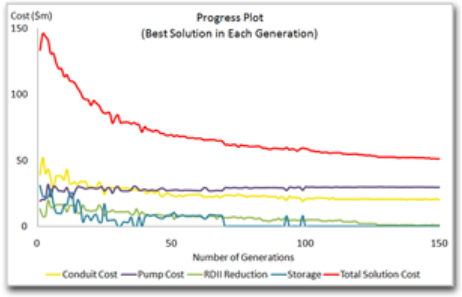


Optimizer CS User Interface

Sensitivity Evaluations

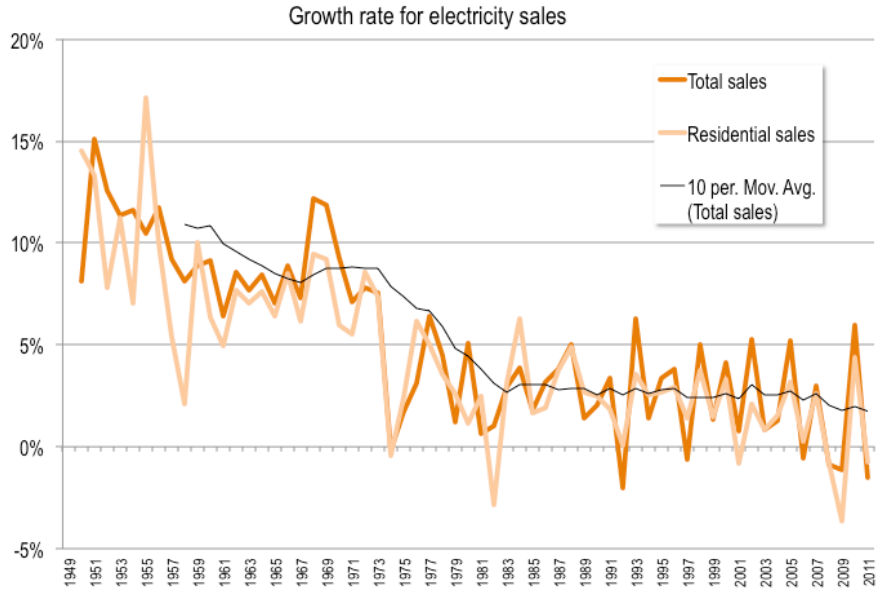
Improvement Category	Baseline Solution Cost ($M)	Optimized Solution Cost ($M)
Gravity Sewer	6.7	5.2
Rising Main	19.3	13.8
Pump Station (Capital)	9.1	6.5
Pump Station (O&M)	24.0	21.5
Storage Facility	4.4	0.0
Rehabilitation	0.0	0.0
Total Project Cost	**63.5**	**47.1**

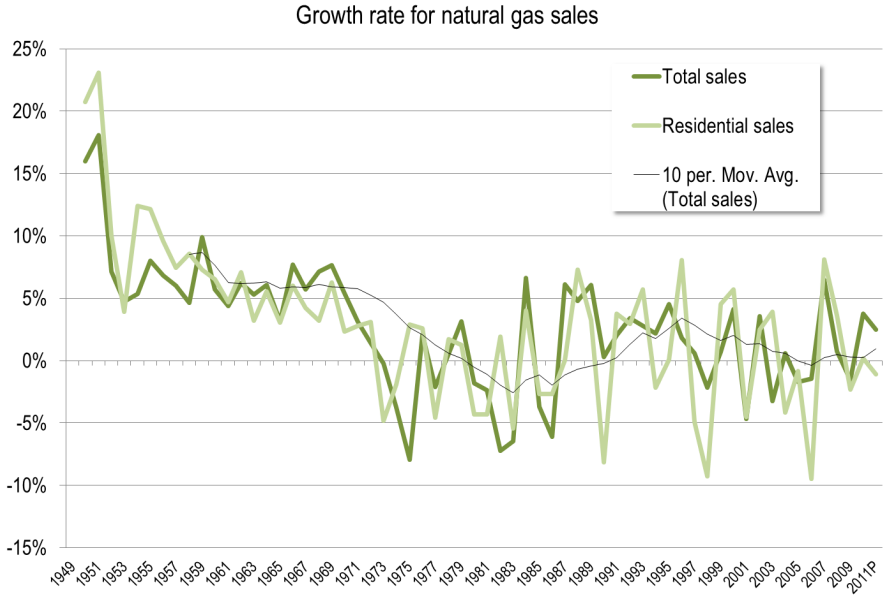
Optimization Solution Cost Summary



Optimization Progress

Slow growth in energy sales





The regulatory paradigm: toward a new *prudence*

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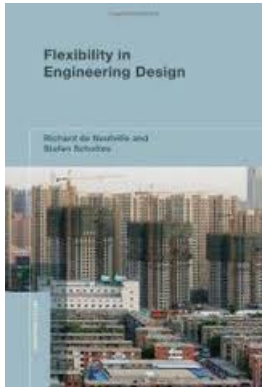
- Rather than a *new paradigm*, regulation can advance a *new prudence*
  - Prudence remains core to the regulatory paradigm, despite changing conditions
  - Efficient achievement of obligatory goals in the absence of competition
- Policy tools for ensuring prudence
  - Performance standards and measurement
  - Monitoring, audits, and compliance reviews
  - Incentives (positive and negative)
- Modern prudence can be refined to include *robust standards* to promote
  - Capital optimization, operational efficiency, and productivity
  - Load management and capacity utilization
  - System reliability, public safety, and service quality
  - Cost, information, and risk management systems
  - Flexible, adaptive, and resilient infrastructure design



Next Gen Infrastructures: F.R.A.M.E. the issue

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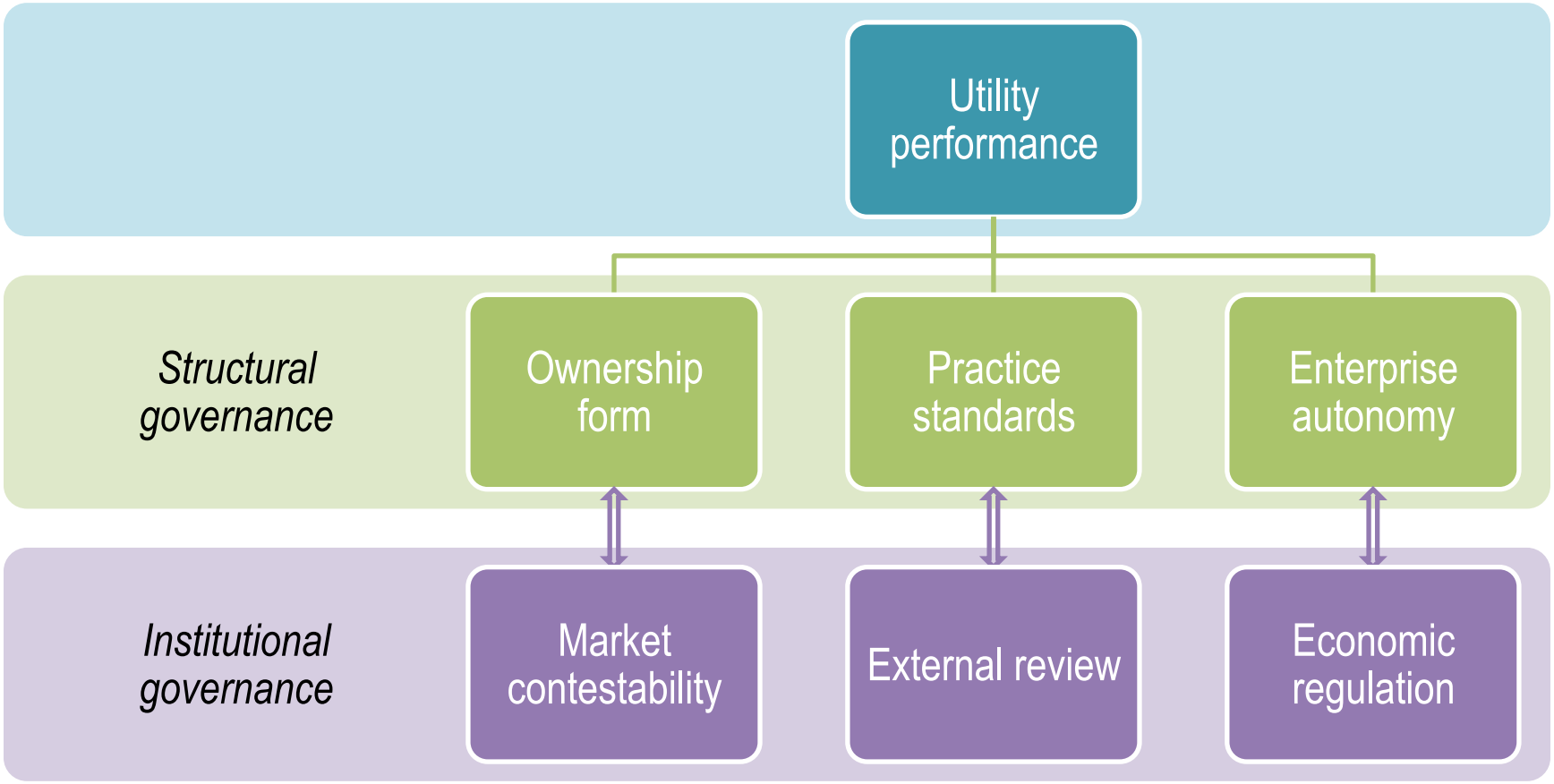
- The value of comparative and cross-national research
- Researchers at NextGen Infrastructures (TU Delft, Netherlands) are working with providers to develop performance indicators (FRAME)
  - Flexibility, Reliability, Availability, Maintainability and Economic (FRAME)
- Flexible design deals directly with the issues of technological and structural scale and uncertainty
- For utility infrastructure, flexibility could be the key to
  - Prudence from the regulator's perspective
  - Risk management from the utility's perspective
  - Sustainability from society's perspective

NEXT
GENERATION
INFRASTRUCTURES

The role of governance in utility performance (Beecher)



From best practices to critical thinking: a collaborative agenda

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- Complexity theory
- Game theory
- Genetic algorithm optimization
- Total cost analysis
- Flexible design
- Emerging technologies
- Supply chains
- Construction management
- Coordination
- Interdependency
- Financial models
- Standards development
- Behavioral economics
- Evaluation methods
- Information systems
- Knowledge transfer
- Infrastructure governance
- Transdisciplinary education

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more IPU research...

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August 5-16.2013 | Kellogg Center | East Lansing, MI
Our flagship event, the Annual Regulatory Studies Program, known as "Camp NARUC," is grounded in sound regulatory theory and accepted practices and incorporates a reasoned approach to contemporary structural and regulatory change. Open only to the public and nonprofit sectors. Join us for one week or two - and "Come Back to Camp" for continuing education! More Information | Register | Fax-in Form

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More Information | Register | Fax-in Form

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Rate School emphasizes the fundamentals of the utility rate setting process, including how to establish revenue requirements and the basic concepts of rate design.
More Information | Register | Fax-in Form

OTHER PROGRAMS

National Conference of Regulatory Attorneys

June 16-19, 2013 | San Francisco, CA
An exciting conference that includes a number of topics that have not been discussed previously including FERC Order 1000, the Internet Protocol transition in telecommunications, water recycling and contamination and important presentation on gas safety and future gas supplies