

How Low Can It Go?

Implications of Falling Usage for Water Utilities

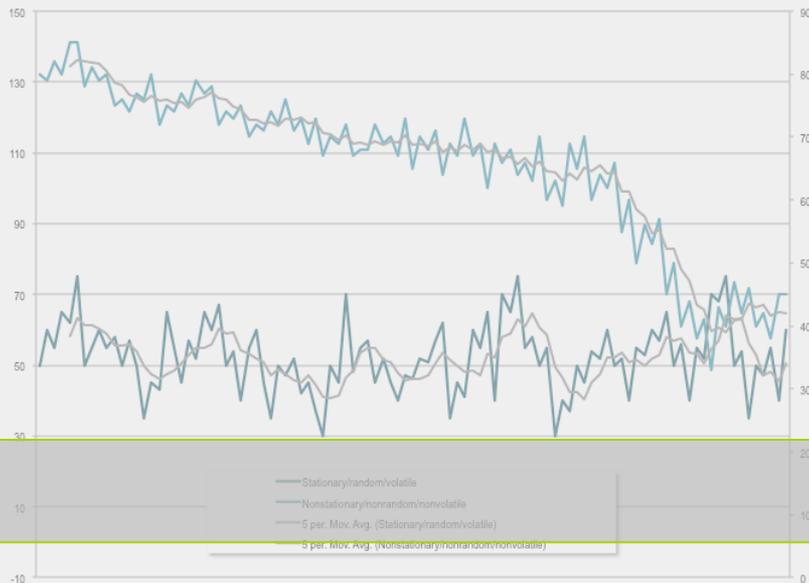
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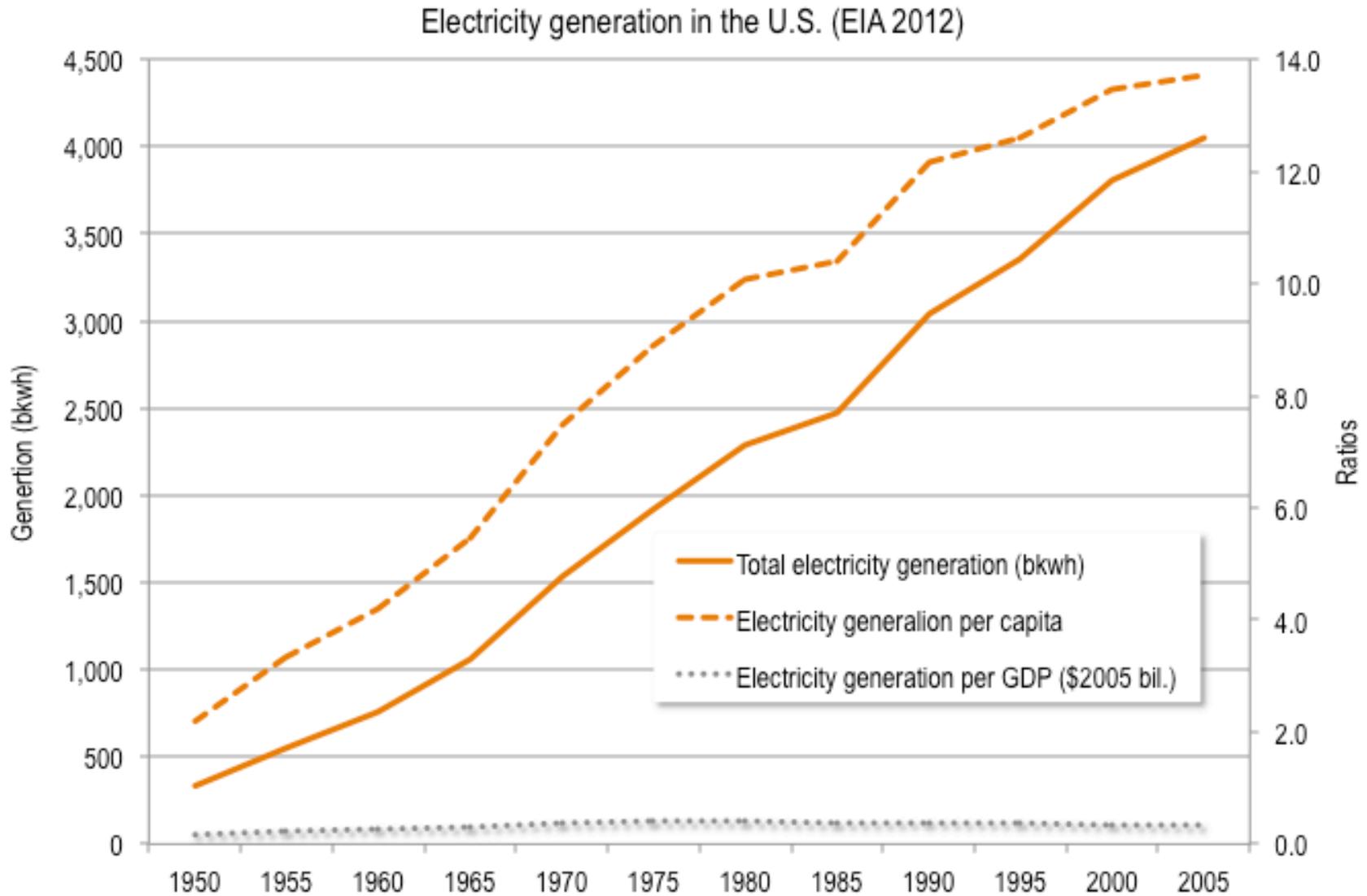


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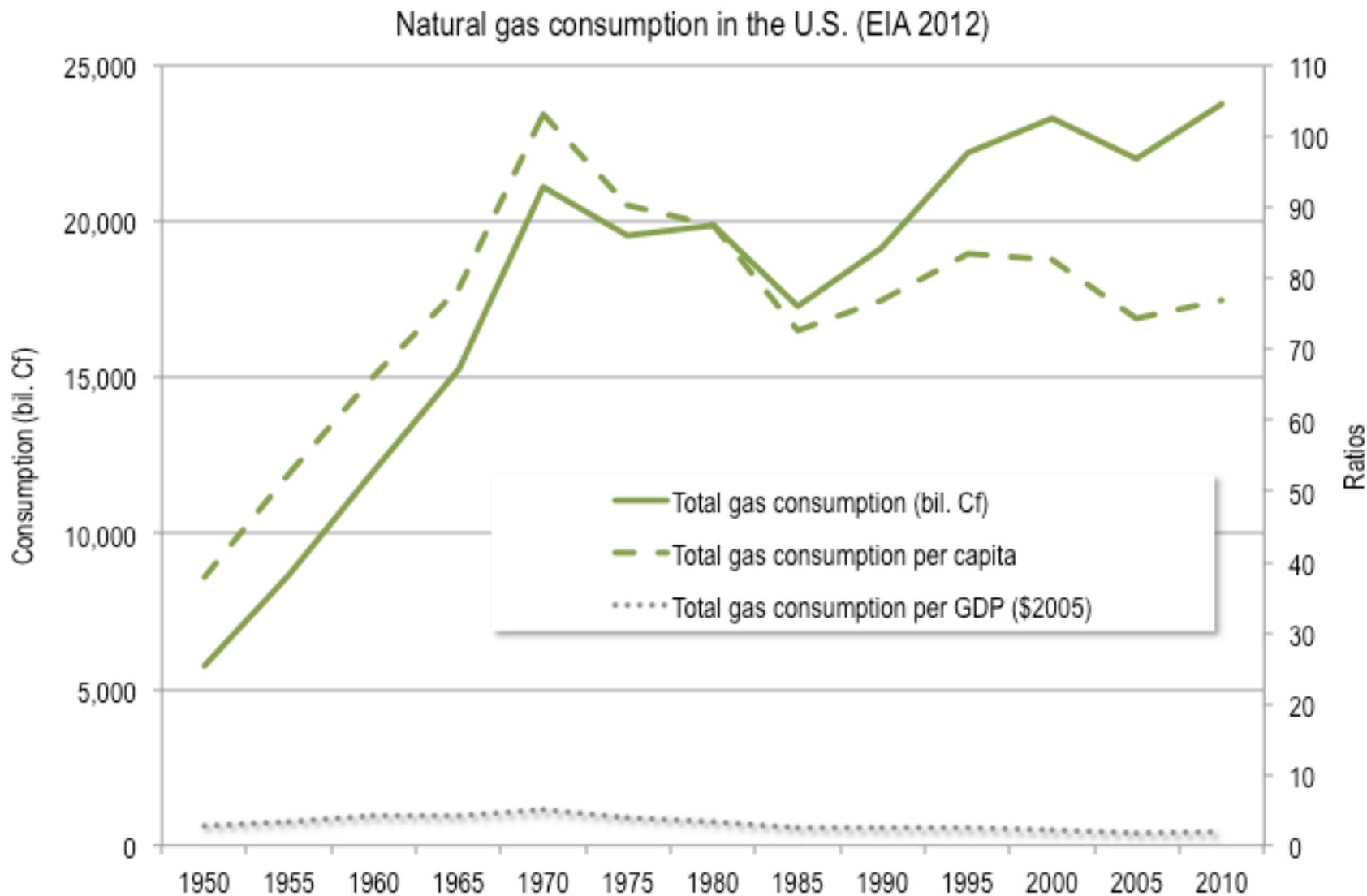
But first... where does it rain more, Dallas or Detroit?



Electricity trends

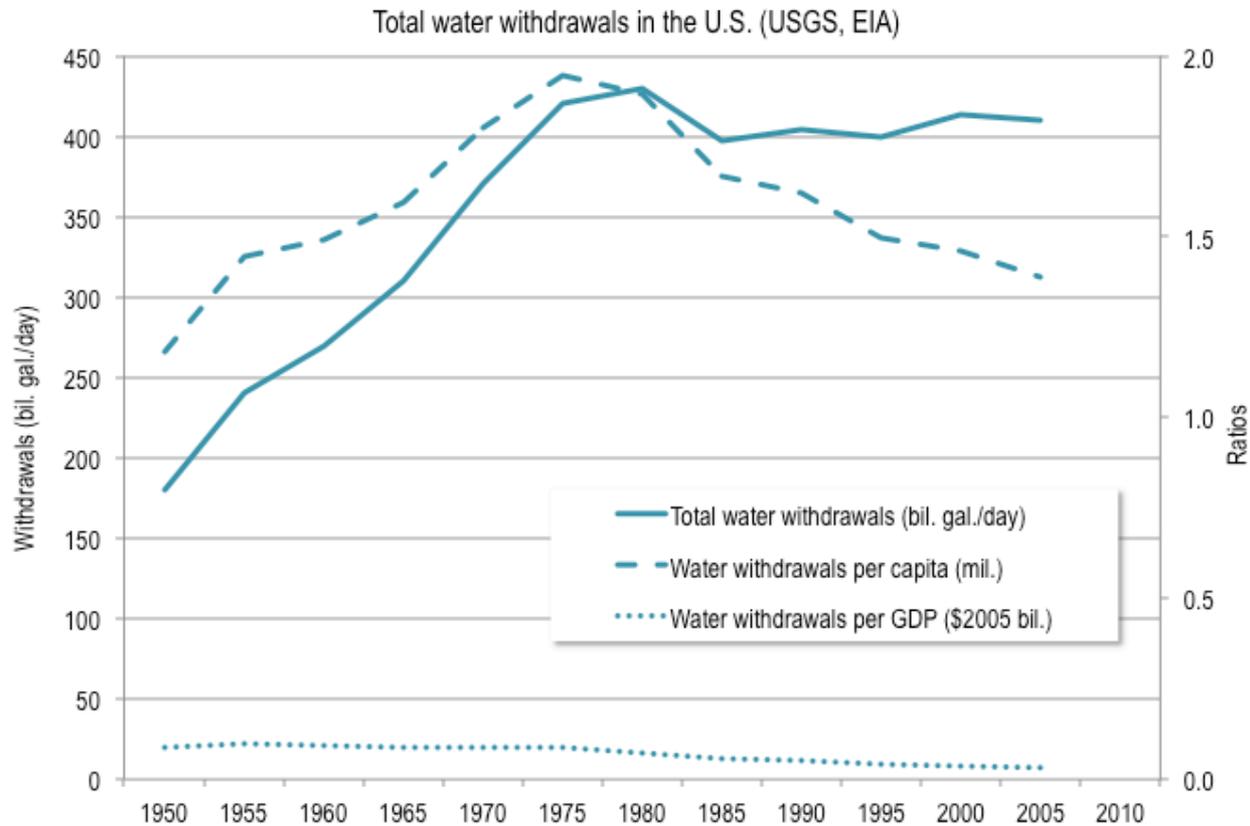


Natural gas trends



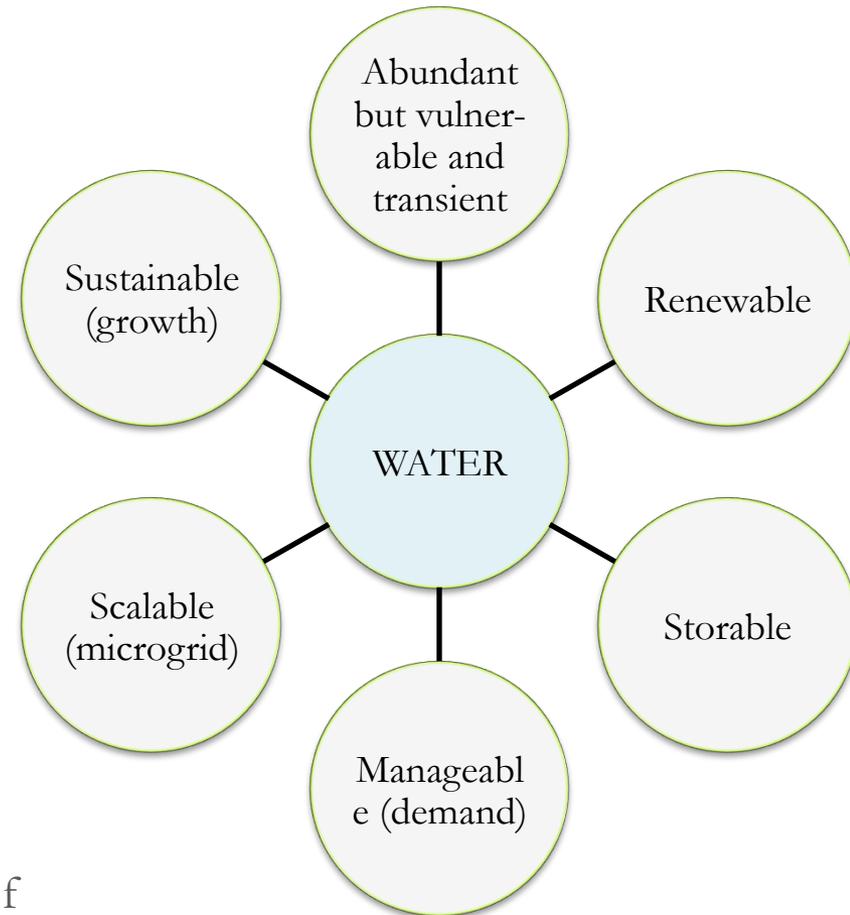
Water trends

- Dramatic and durable efficiency gains without loss of technical functionality
- Usage remains stable even in the context of macroeconomic growth
- Water appears to defy “Jevons paradox” for resource consumption



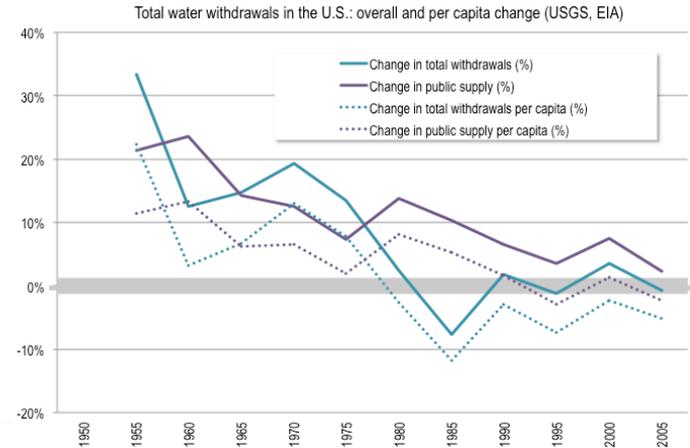
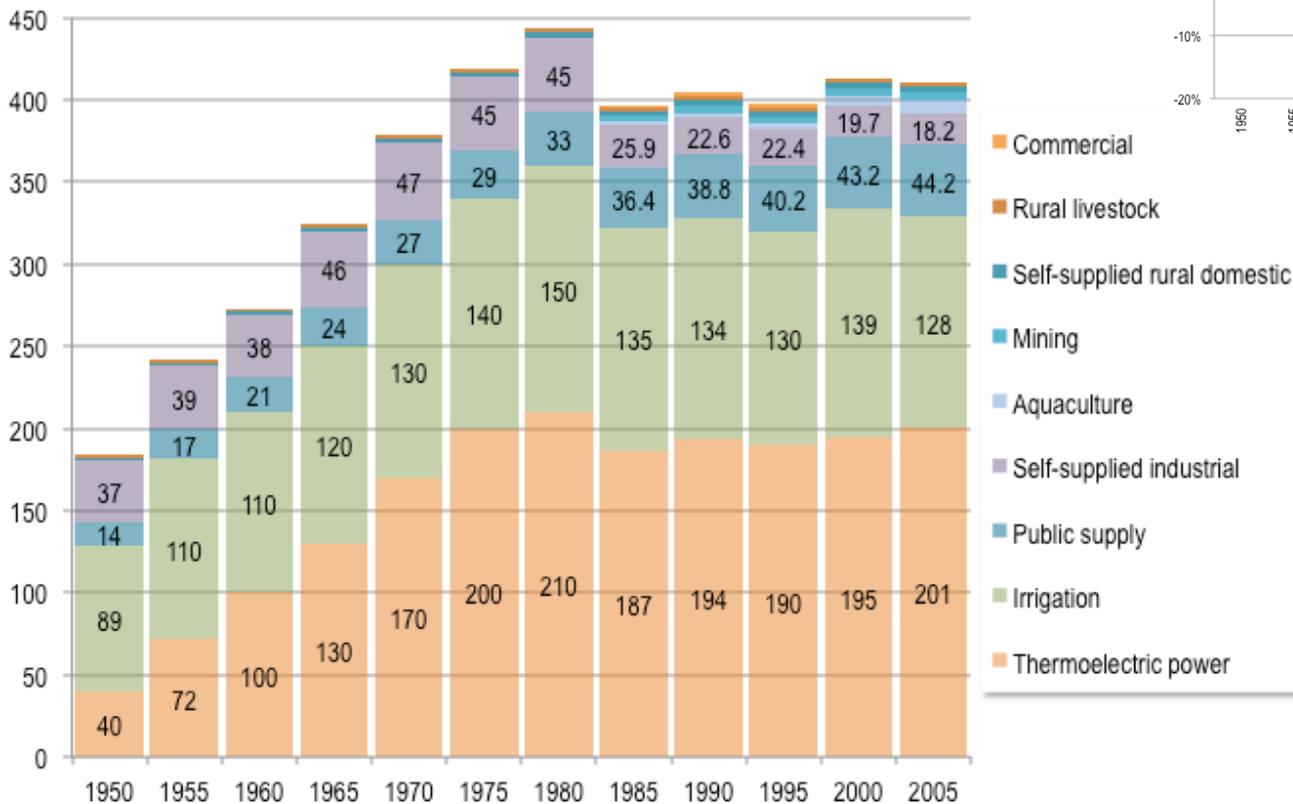
Water v. energy grids: water has properties energy wishes it had

- For decades, despite capital intensity of water services, a central policy goal has been to get customers *on the water grid*
 - ▶ Off the water grid means wells and septic systems and in-home treatment
- Water grids provide multiple social benefits
 - ▶ Public health and welfare
 - ▶ Fire suppression
 - ▶ Sanitation services
 - ▶ Environmental protection
 - ▶ Network economies
- Fundamental technological disruption seems less likely for water than for energy
 - ▶ Indoor demand is substantially price inelastic
 - ▶ Water grids must be supported by lower levels of more efficient water usage



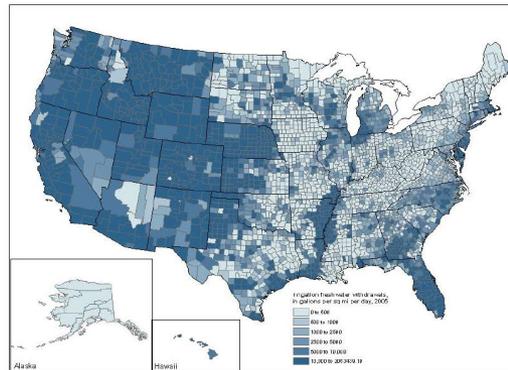
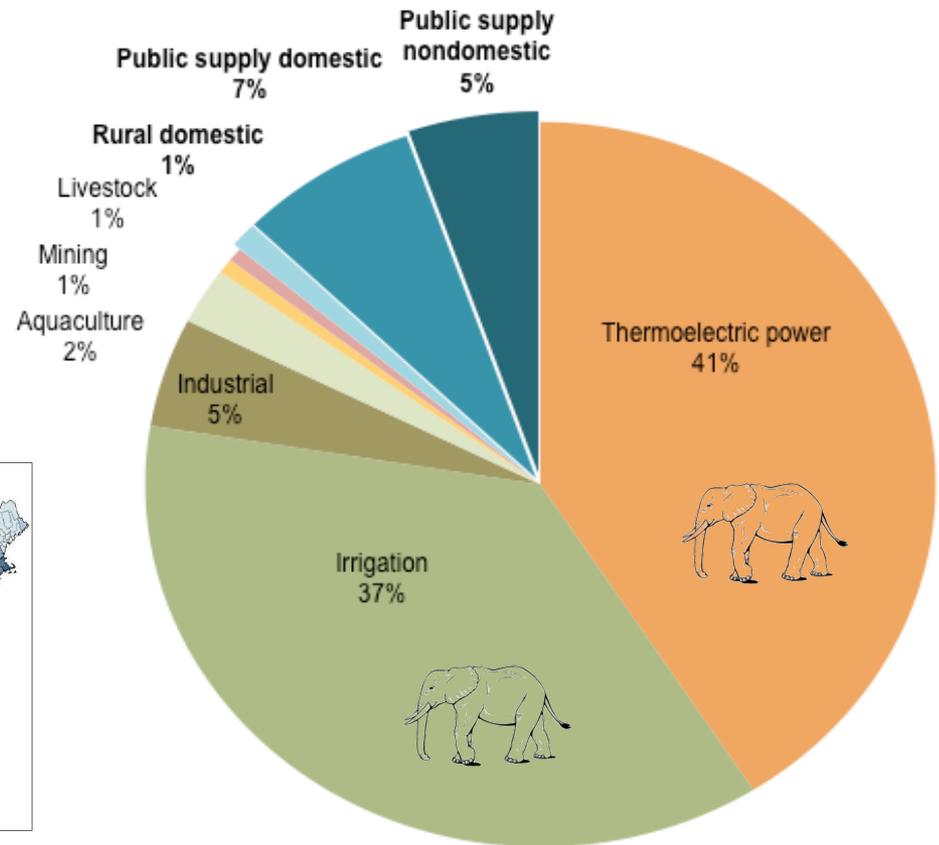
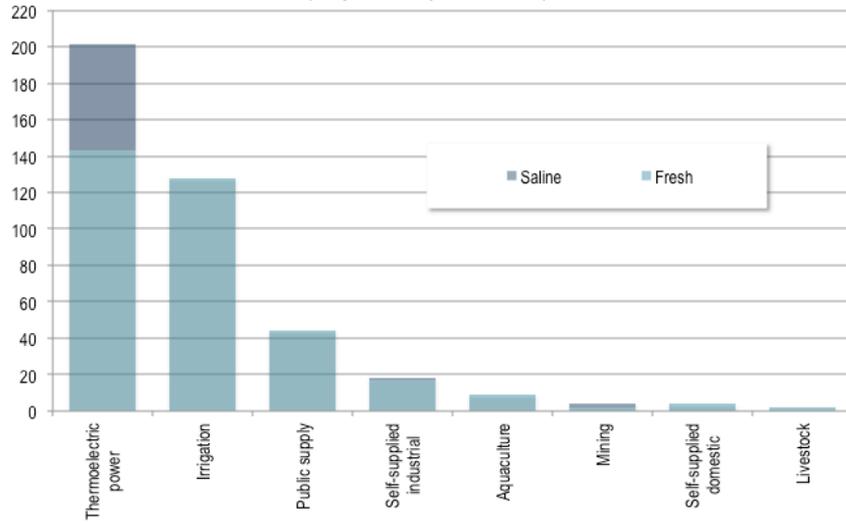
Water withdrawals in the US

Total fresh and saline water withdrawals in the U.S. (bil. gal. daily, USGS 2005)

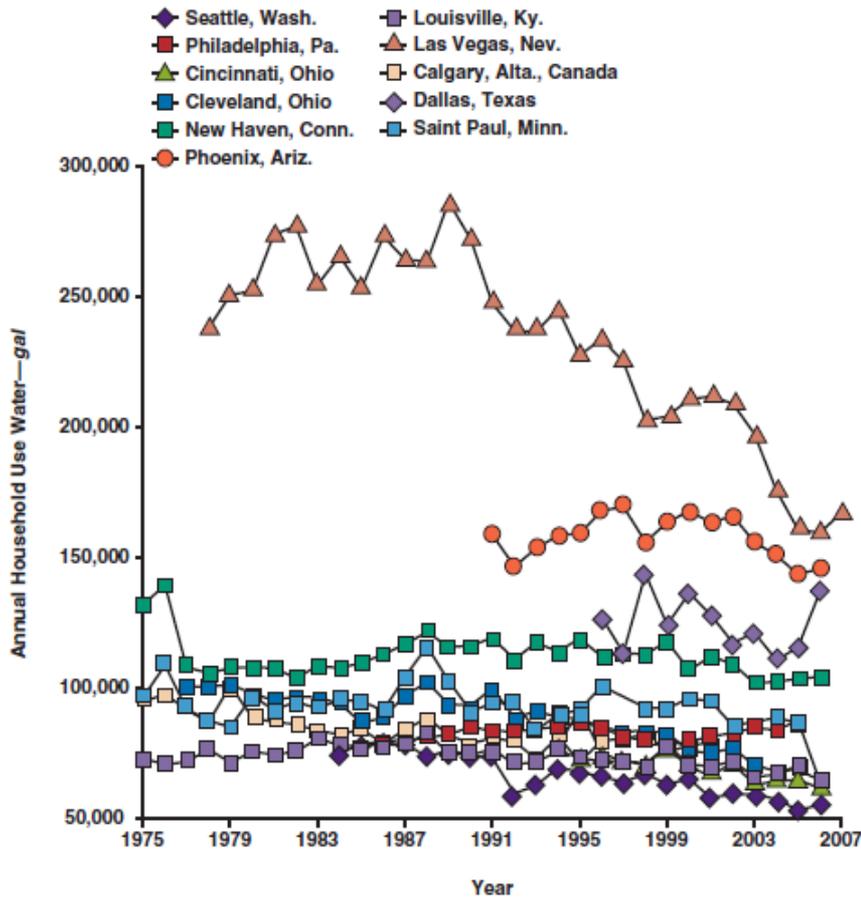


Freshwater withdrawals by sector

Fresh and saline water withdrawals in the U.S. by sector
(bil. gallons daily, USGS 2005)

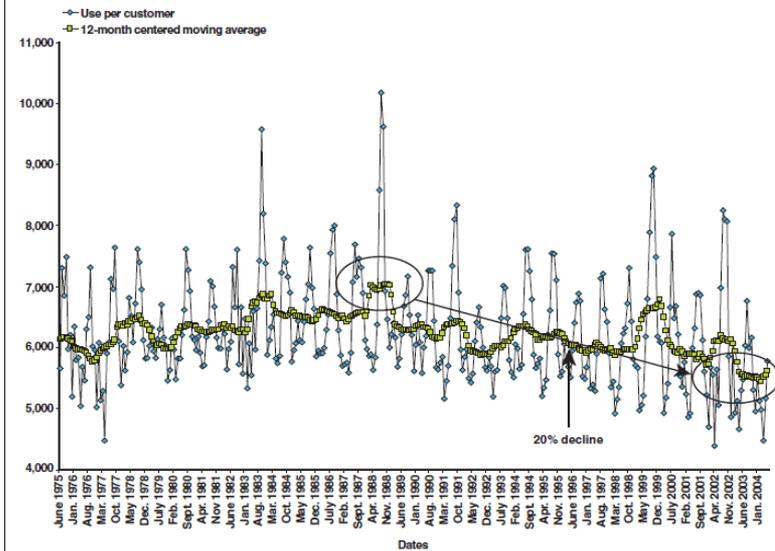


Water usage in U.S. cities (WRF, 2011)



Source: Coomes, P., T. Rockaway, J. Rivard, and B. Kornstein. North American Water Usage Trends Since 1992. ©2010 Water Research Foundation. Reprinted with permission.

FIGURE 4 Water use per residential customer of the Louisville (Ky.) Water Company, 1975–2000

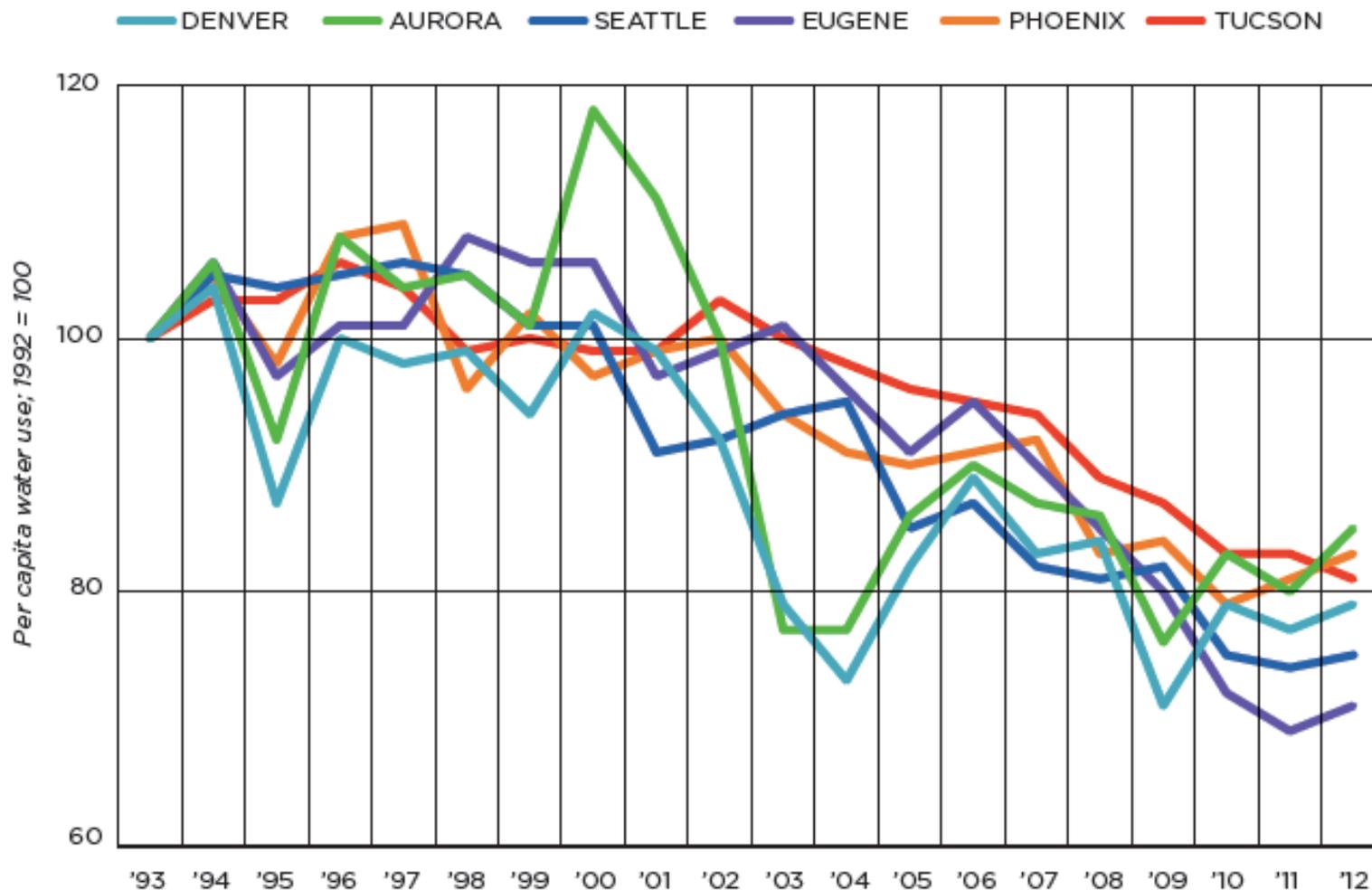


Source: Coomes, P., T. Rockaway, J. Rivard, and B. Kornstein. North American Water Usage Trends Since 1992. ©2010 Water Research Foundation. Reprinted with permission.

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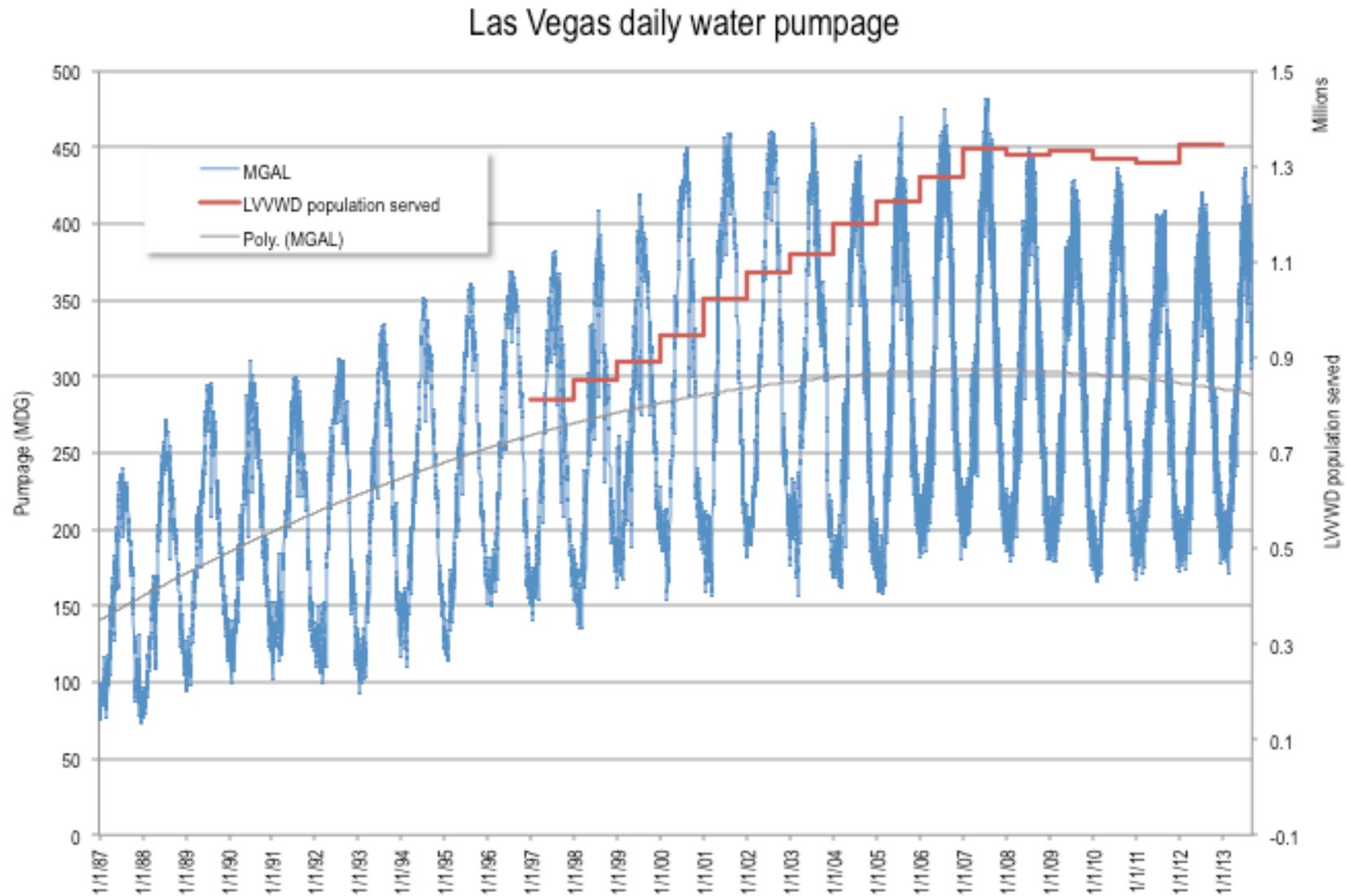
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Water usage in western U.S. cities (Frost, 2013)

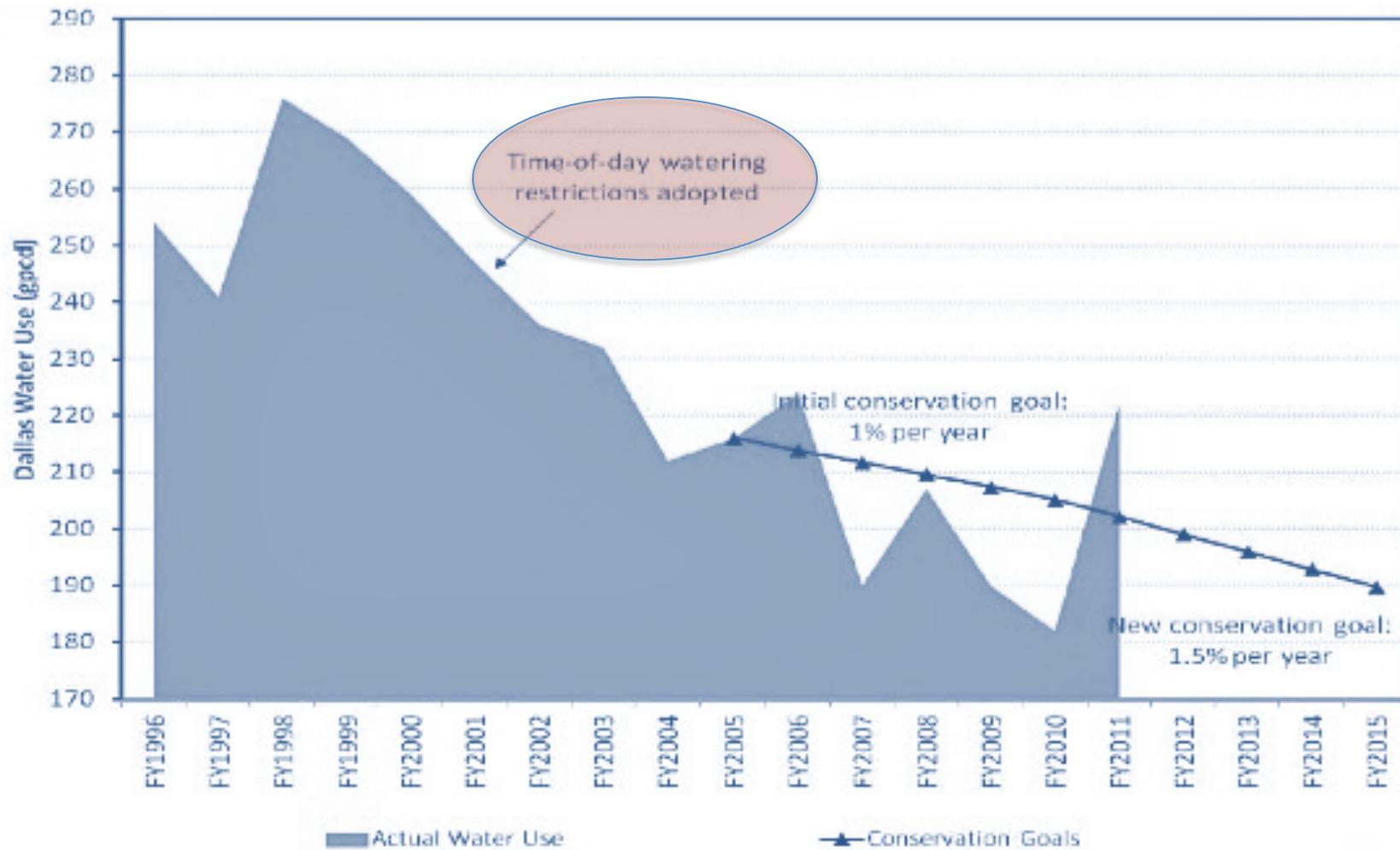


SOURCES: Denver Water, Aurora Water, Seattle Public Utilities, Eugene Water and Electric Board, Phoenix Water Service, Tucson Water

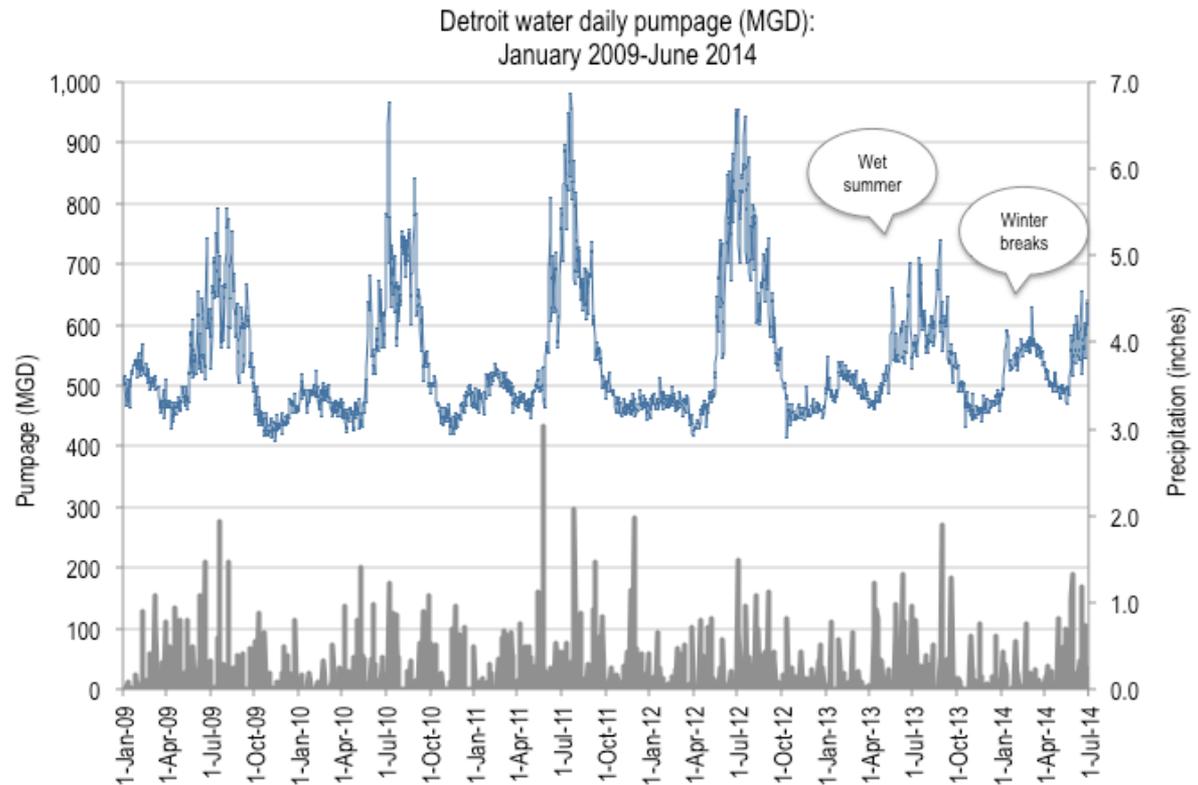
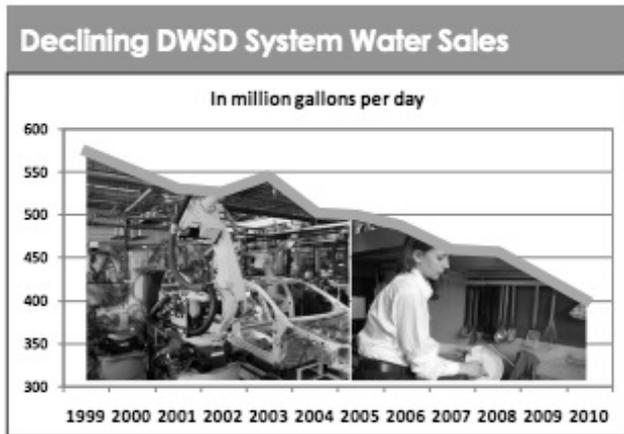
Las Vegas daily water pumpage (1987-2013)



Dallas water consumption trend (1996-2011)

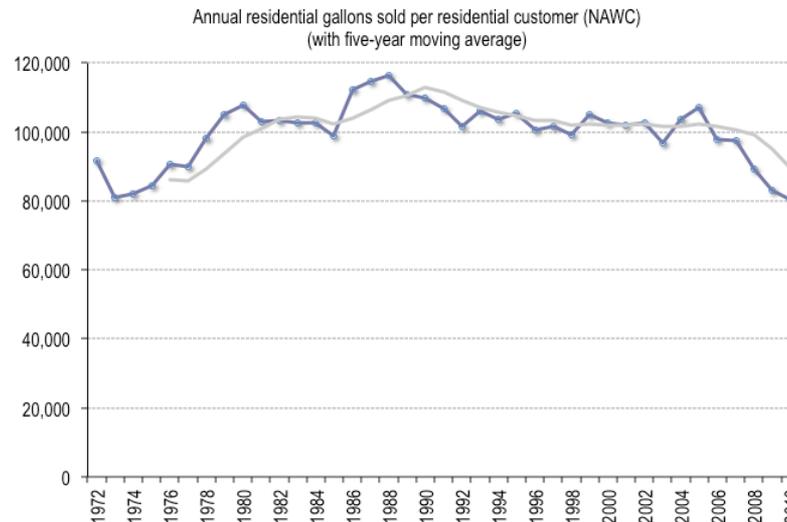


Detroit daily water pumpage (2009-2014)



Falling water usage

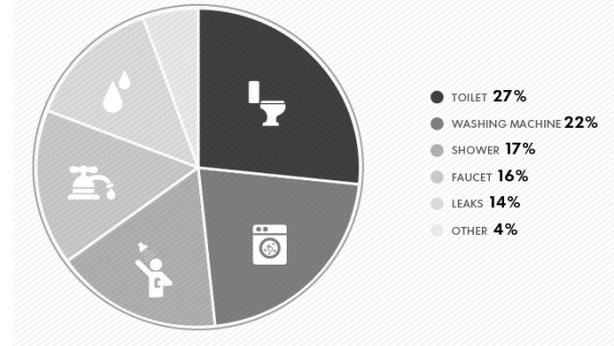
- Aggregate, per-connection, and per-capita water use is stable or falling
- Declining annual sales of 1-3% are not uncommon (25% cumulative per WRF)
- This nonlinear trend may reach an equilibrium in perhaps 10-15 years (?)
- Population and economic activity remain significant local drivers
- Persistent usage volatility is associated with climate and weather
- Developing economies still see growth while legacy cities see decline



Apparent causes for falling water usage in the U.S.

■ Per-connection or per household

- ▶ Demographic shifts (population, household size)
- ▶ Property (lot) size and growth policies
- ▶ Nature of commercial and industrial activities
- ▶ Irrigation efficiency (practices, codes, efficiencies)
- ▶ Aging water meters that under-register (minor role)
- ▶ Effects of recession on economy and income (temporary?)
- ▶ Cost-driven price effects on discretionary use (elasticity)



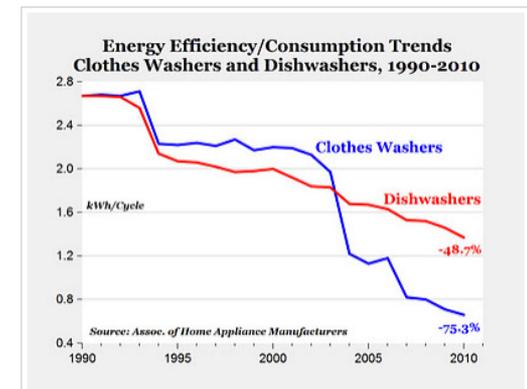
■ Per-capita or per-function

- ▶ Efficiency standards (EPA Act 1992), codes, and ordinances
- ▶ Commercial and industrial processes and technologies
- ▶ Changing culture and environmental ethic (e.g., lawn watering)

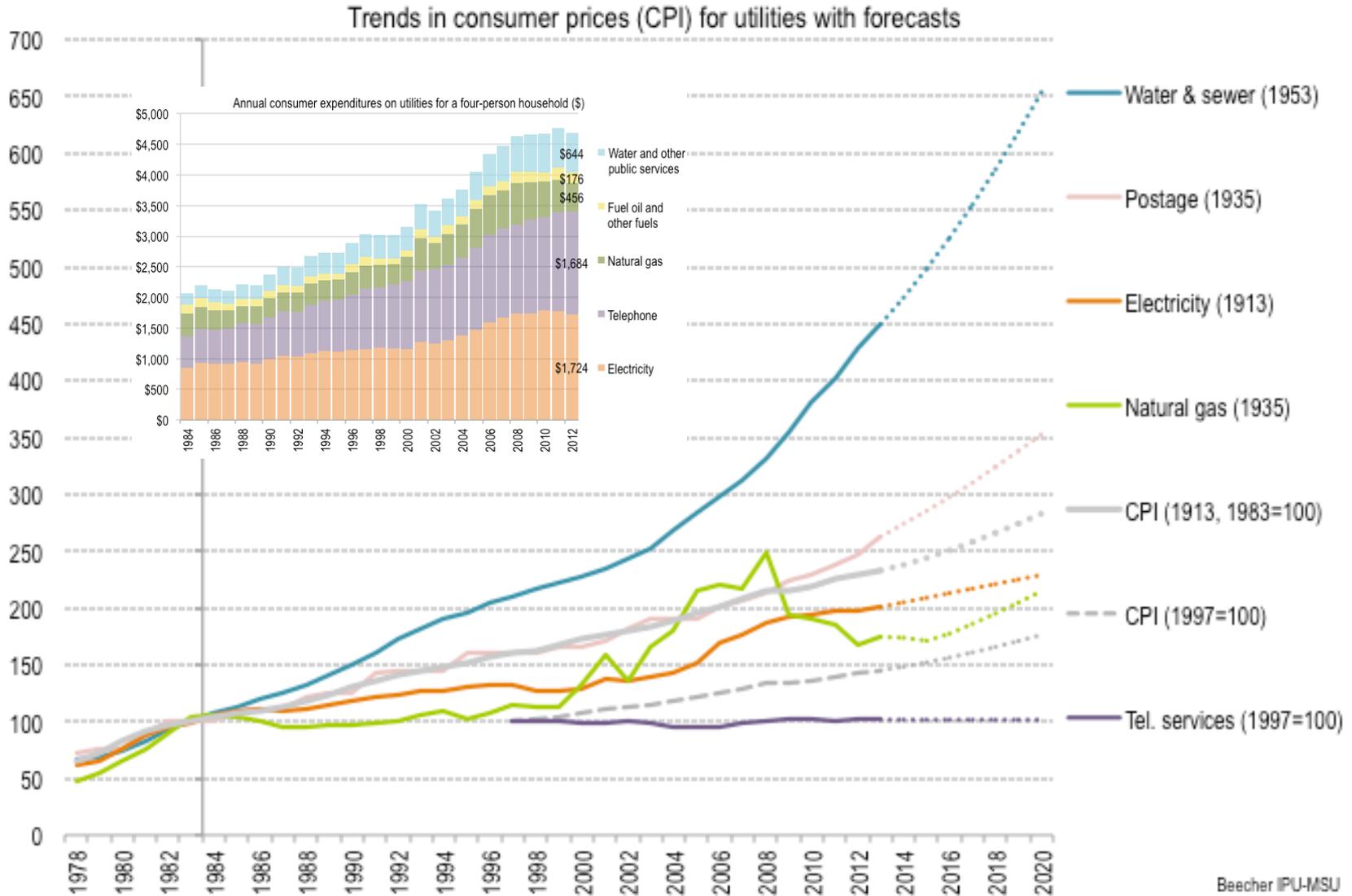


■ No new offsetting uses for potable water

- ▶ Except for hydraulic fracturing – unregulated (by EPA) and may count as mining (by USGS)
- ▶ Compare to energy



CPI trends for utilities (U.S.) with forecast



Beecher IPU-MSU

Why water prices may matter more today

- Water rates are rising much faster than inflation generally or for other utilities
- Water usage is relatively price inelastic but not perfectly so
- Discretionary use (nonresidential and outdoor residential) is more price-elastic (responsive)
- Could be entering a more price-elastic segment of the demand curve
- Emerging evidence suggests responsiveness to marginal prices as well as to the total bill
- Well-designed prices (increasing block, seasonal rates) can help close the peak-to-average ratio

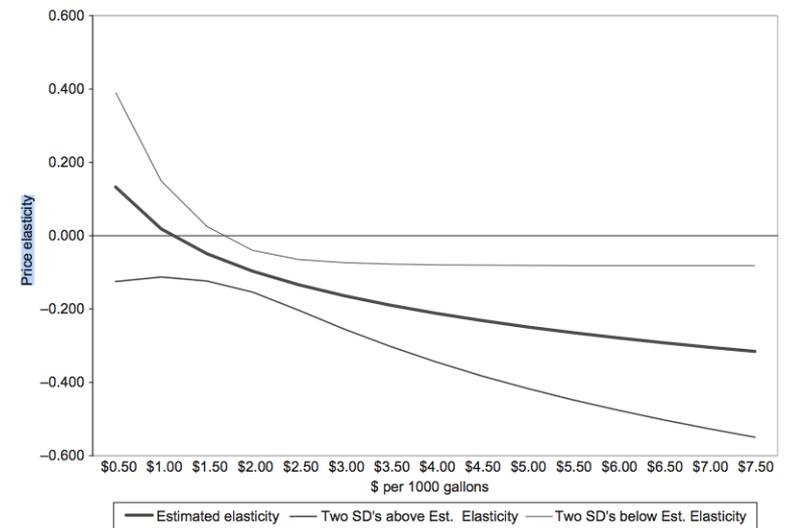
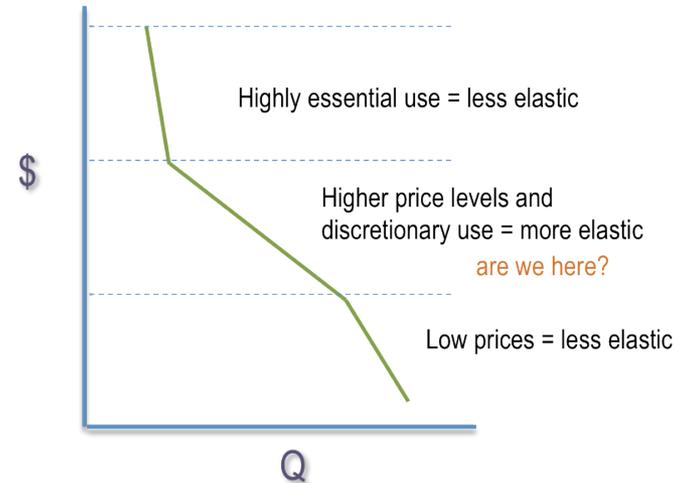
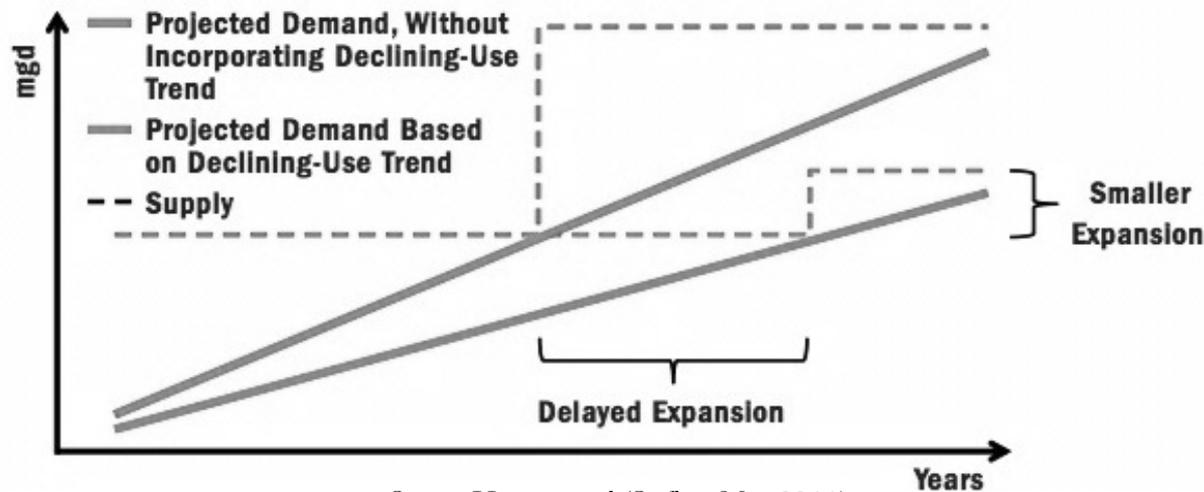


Fig. 1. Estimated price elasticities and ranges at different marginal prices

Benefits of end-use efficiency

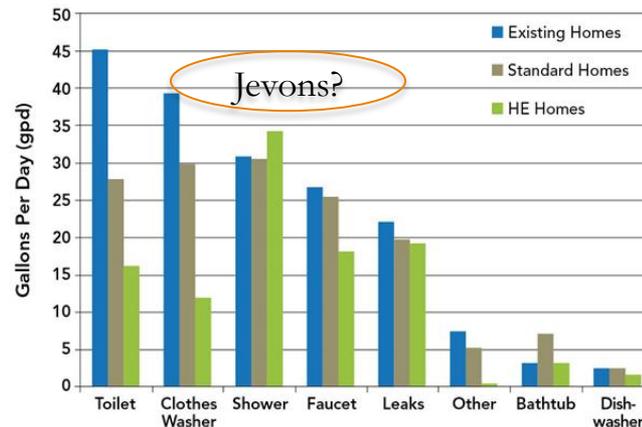
- Efficiency lowers costs and revenue requirements (“nega-gallons”)
 - ▶ Short-run: avoid variable operating inputs – *including energy*
 - ▶ Long-run: extend asset life and resize, postpone, or avoid new capacity
- Efficiency improves water system operation and management
 - ▶ Prudent capacity utilization through reductions of peak demand
 - ▶ Reduced revenue and earnings volatility (risk)
- Efficiency cannot avoid all system costs – particularly in the replacement cycle
 - ▶ Hyper-efficiency may have deleterious consequences for systems and customers



Source: Hunter, et al (Opflow, May 2011)

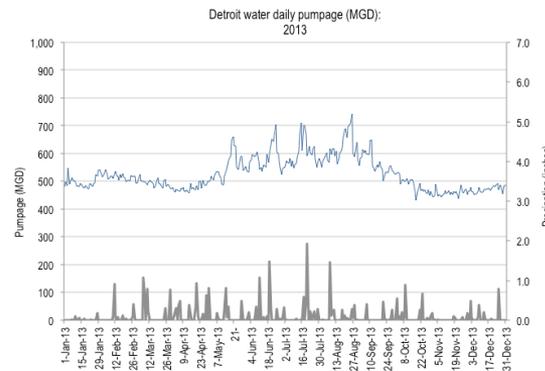
A note on hyper-efficiency for indoor usage

- Technological standards will continue to drive indoor usage down
 - ▶ Households are becoming much more efficient (<40 gpcd for indoor use)
 - ▶ Marginal value of conservation diminishes due to current operational requirements
 - ▶ Local conservation may have limited global impact (except for energy usage)
 - ▶ Attention should turn to outdoor use and other sectors (irrigation and cooling)
- Hyper-efficiency (<25 gpcd) has operational consequences
 - ▶ Low flows may cause water pressure and quality issues (need for flushing)
 - ▶ Low flows also affect wastewater operations (flushing, pressure, or vacuums)
 - ▶ Increased use of maintenance water may offset conservation savings
 - ▶ Indoor water can be captured as a resource for reusing and recharging



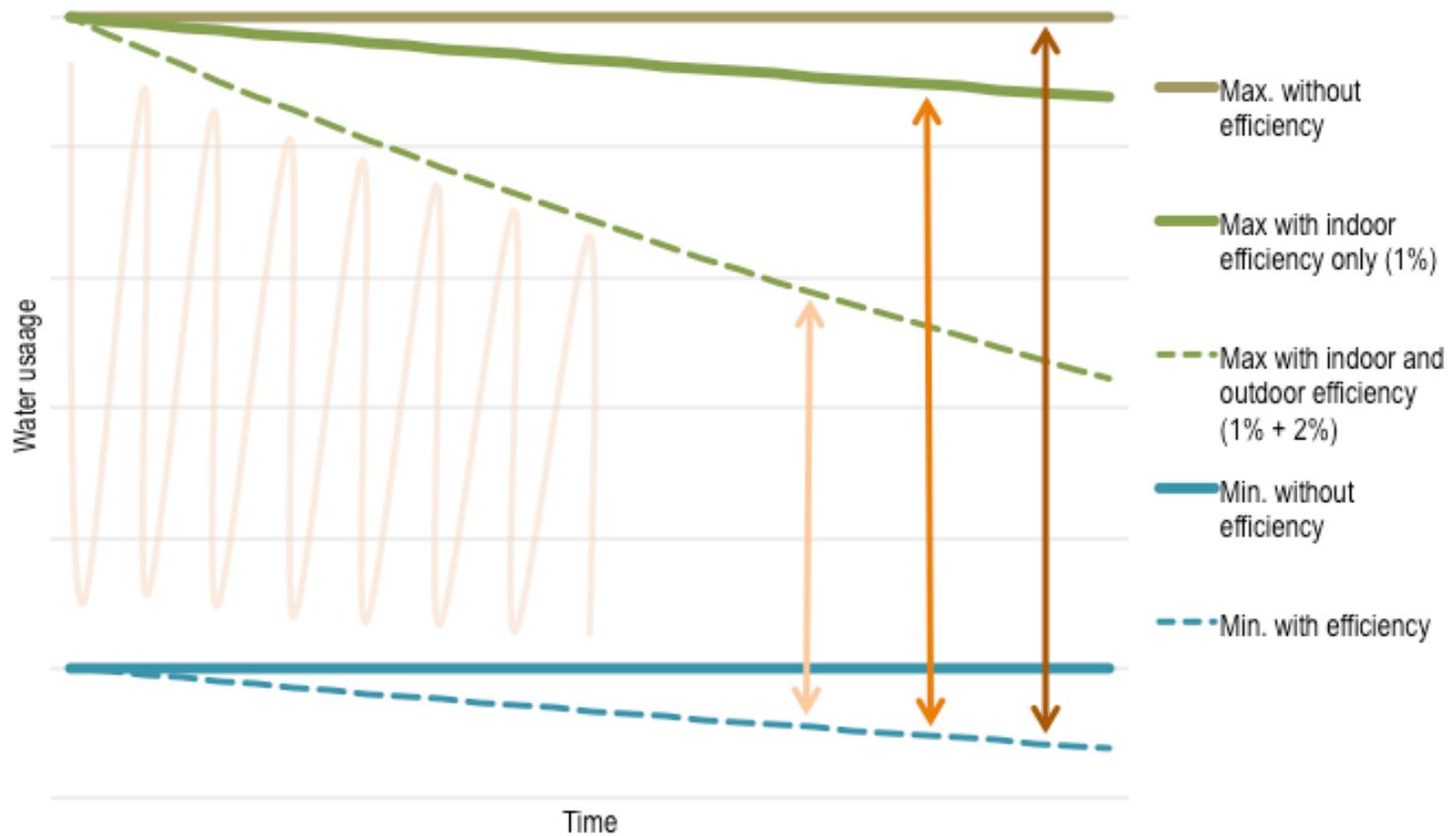
Efficiency and volatility

- Gross sales volatility is primarily a function of weather-sensitive outdoor use
 - ▶ Indoor usage is less responsive (elastic) relative to price and other changes
 - ▶ Rising variable prices and bills could drive down outdoor usage significantly
- Trends in indoor and outdoor usage determine the weather effect on water sales
 - ▶ Supply-side (leak control) and indoor efficiency will lower base-load usage, although only the latter will affect sales revenues
- Sales and revenue volatility remain a function of outdoor water usage
 - ▶ If maximum (outdoor) use persists or rises, volatility will *increase* due to the larger disparity between peak and off-peak usage
 - ▶ If maximum (outdoor) use falls, volatility will *decrease* due to narrowing of peak to off-peak



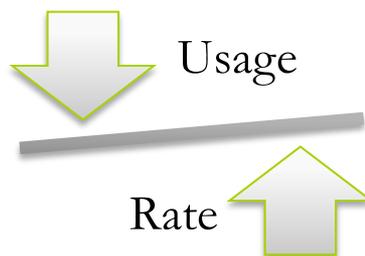
Outdoor efficiency will reduce sales and revenue volatility

Revenue volatility is a function of indoor and outdoor efficiency



The conservation conundrum: rates and revenues

- For most, cost of service is driven more by infrastructure than the commodity
 - ▶ Short-run marginal costs tend to be low given substantial fixed capacity
- In theory, other things equal, reduced water usage requires higher rates
 - ▶ Revenue neutrality suggests that bills would remain about constant – and actually be slightly less due to savings in variable costs
- In reality, water bills are going up not due to lower usage but due to higher costs
 - ▶ Total costs are rising for most systems due to infrastructure investment
 - ▶ Unit costs are rising for some systems due to loss of customers and scale economies
- Utilities have a difficult messaging problem with regard to higher water bills
 - ▶ Efficiency cannot promise lower bills, but it should promise “lower highs”



Revenue shortfalls for water utilities: key culprits

- Lack of timely rate adjustments
 - ▶ Utility and regulatory lag and rate politics (public systems)
- Inadequate cost and demand forecasting
 - ▶ Test year for ratemaking
- Rate design
 - ▶ Rate blocks and dependence on variable usage
- Concurrent loss of other revenues
 - ▶ Subsidies and fees

Lag, sales, and returns

- Firm value does not depend on sales growth but on realized returns
- Achieving returns depends on relative cost and efficiency trends between cases
- Regulation plays an important role in maintaining the risk-reward relationship

		Efficiency trend between rate adjustments	
		<i>Increasing operational efficiency</i>	<i>Decreasing operational efficiency</i>
Cost and sales trend between rate adjustments	<i>Falling costs and/or rising sales</i>	Achieving returns is likely	Achieving returns is possible
	<i>Rising costs and/or falling sales</i>	Achieving returns is possible	Achieving returns is unlikely

Revenue assurance mechanisms (decoupling)

- Purportedly addresses the utility’s “throughput incentive” (to sell more)
- Decoupling conflicts with
 - ▶ Price signals about value and consumer sovereignty
 - ▶ Concept of capacity costs (tends to perpetuate legacy costs)
 - ▶ Preference for variable and dynamic pricing (looks very “fixed”)
 - ▶ Incentives for utility efficiency and performance (including effect of regulatory lag)
 - ▶ Risk allocation under the social compact and traditional economic regulatory model
- Alternatives to decoupling
 - ▶ “Organic” decoupling with more efficiency over time (i.e., do nothing)
 - ▶ More frequent rate cases to address “utility lag” in recognizing change
 - ▶ Prospective (forward-looking) test year for both costs and sales
 - ▶ Evidence-based rate design to provide stability from base usage
 - ▶ Demand-repression factors to account for price-elasticity effects in rate cases
 - ▶ Adjustment mechanisms with checks on prudence, earnings, and allowed returns
 - ▶ Improved demand forecasting and modeling (beyond moving averages)

Rate revenue is a product of a numerator and denominator

*Test year, cost and revenue
adjustments,
and rates of return*



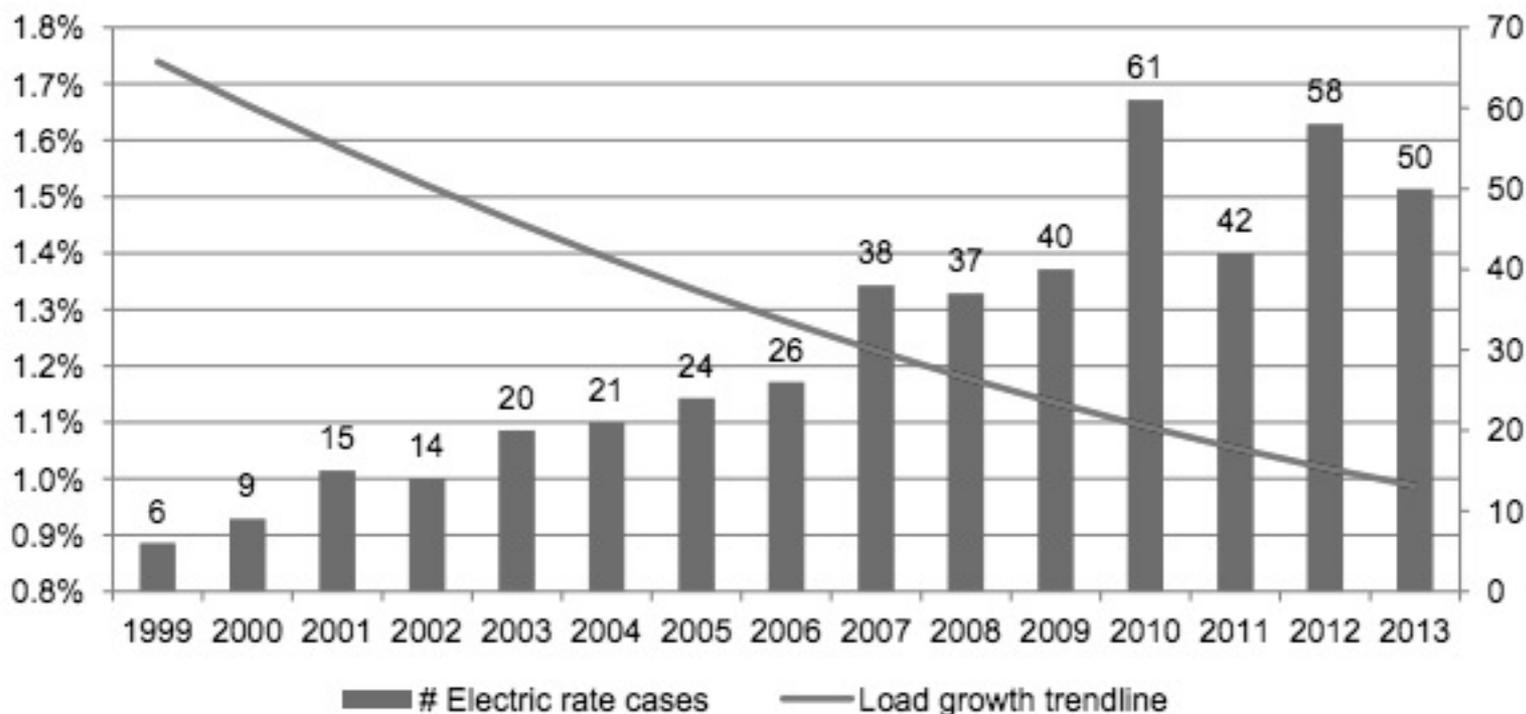
$$\text{Rates} = \frac{\text{Revenue requirements}}{\text{Sales}}$$

*Forecasting, analysis, and
demand modeling*



Declining usage and rate cases (electricity)

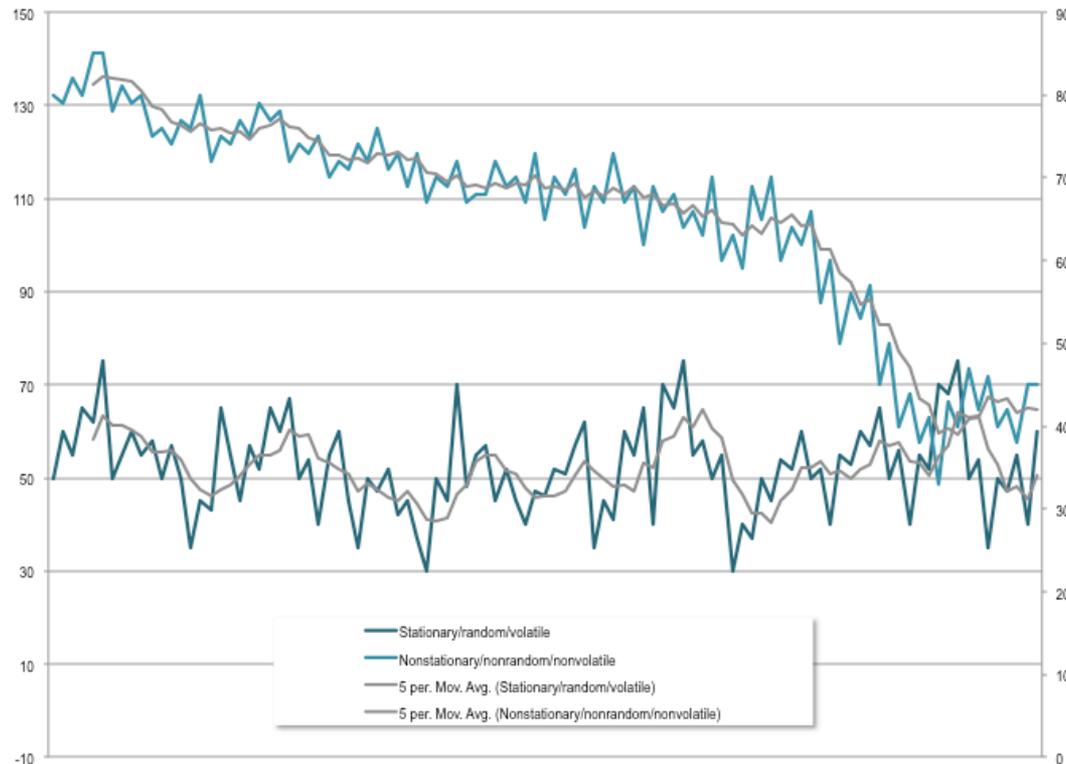
Figure 5: Electric rate cases filed by year and US load growth %, 1999-2013



Source: US Energy Information Administration (EIA), CRA research

Moving averages

- Moving averages may be inadequate for forecasting and ratemaking
- A high-volatility but stationary trend (lower line) may be easier to manage than a low-volatility but non-stationary trend (downward trending line)
- Revenues will always lag during a non-stationary downward trend



From passive to active forecasting (Seattle)

- Active forecasting considers various determinants (endogenous and exogenous)
- Statistically adjusted end-use modeling can be used
- More research is needed to lower forecasting costs and improve accuracy

Actual Water Demand and Past Forecasts

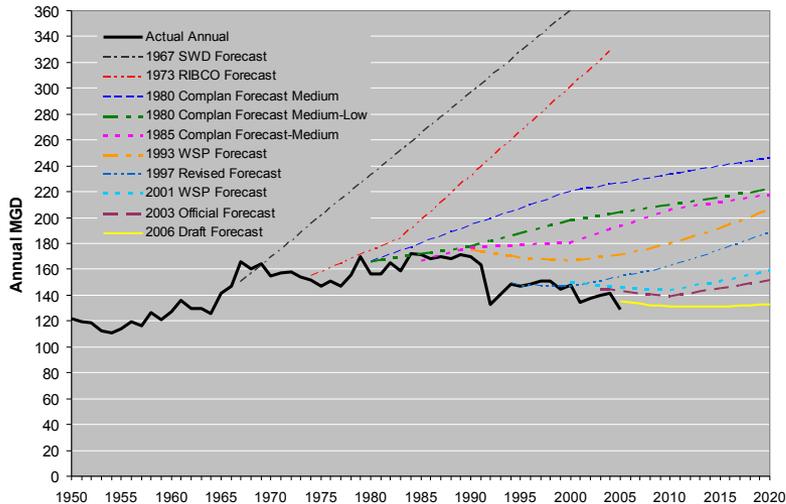
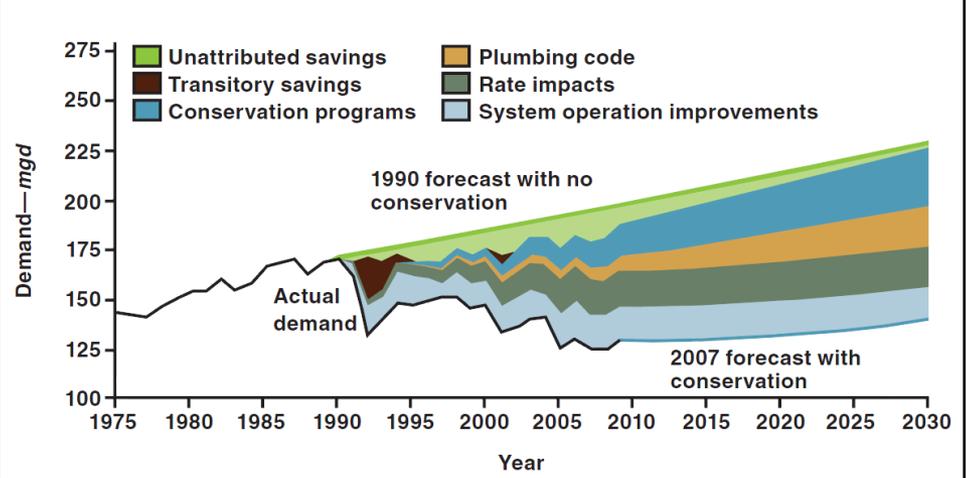


FIGURE 2 Demand forecasts with and without conservation

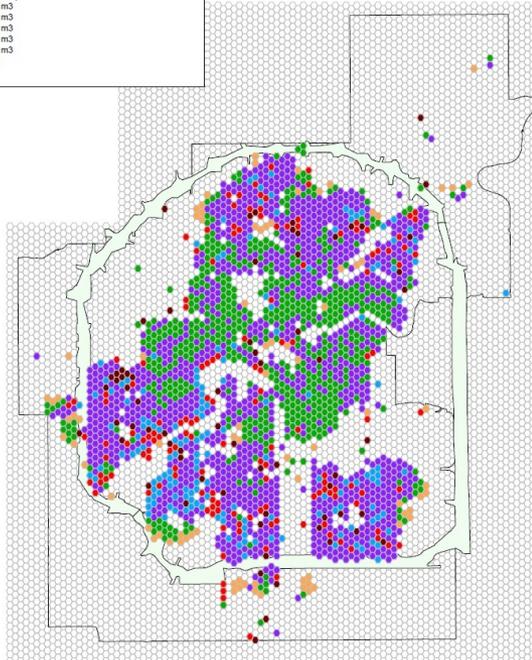


Source: Graphic courtesy of Bruce Flory, Seattle Public Utilities (2009)

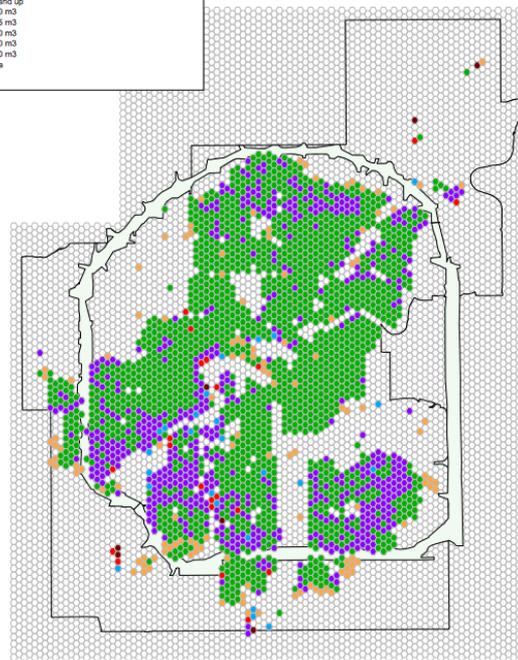
Mapping water usage (Epcor, 2002, 2008, and 2013)

- Geographic information systems (GIS) can be used to map demand
- Data and models can improve understanding of demographic patterns

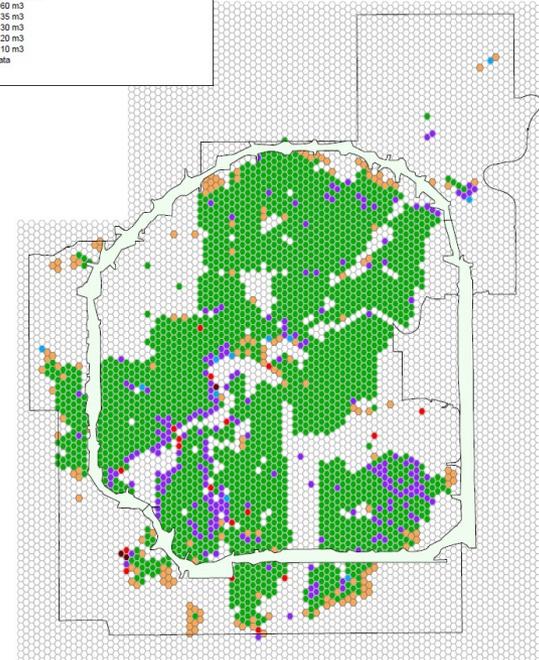
2002 Monthly average consumption ranges per hexagon



2008 Monthly average consumption ranges per hexagon



2013 monthly average consumption ranges per hexagon

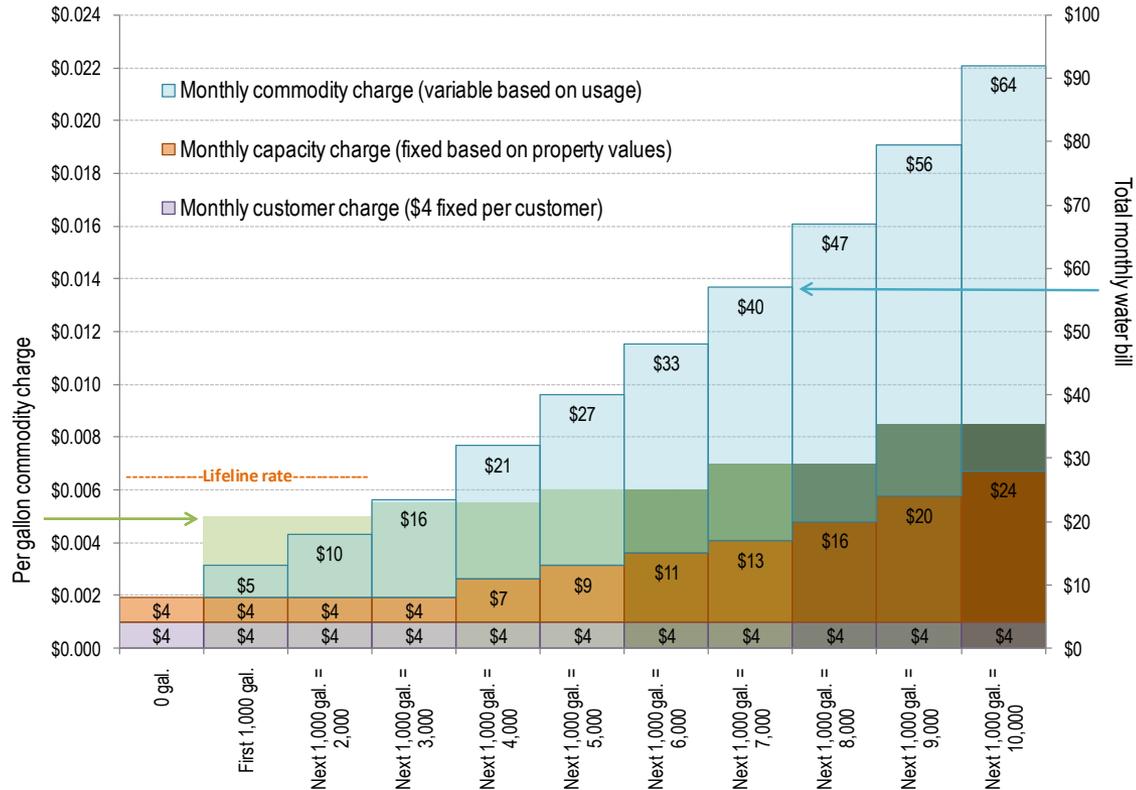


Fixing revenues by fixed prices

- Water sector should resist the impulse to move toward fixed-variable pricing
 - ▶ In the long run, *all costs are variable* – and pricing should reflect this
- High fixed charges
 - ▶ Undermine affordability and equity, where low-use subsidizes high-use
 - ▶ Undermine price signals to promote efficient outdoor usage (perpetuates peaking)
- Revenue stability can be provided by well-designed block or seasonal rates
 - ▶ First blocks can provide considerable stability
- New variable pricing models may be needed
 - ▶ Use of peaking factors to improve cost allocation and rate design
 - ▶ Use of three-part tariffs (customer, capacity, commodity)
 - ▶ Use of property value to assign some fixed capacity costs
 - ▶ Dynamic pricing is less applicable to water due to storage (like natural gas)

Multi-objective water pricing

- Multi-objective rates can help achieve both equity and efficiency
 - ▶ Lifeline rate at lowest block for affordable access to meet basic needs
 - ▶ Graduated capacity charge based on property value (related to fire protection)
 - ▶ Increasing block rate based on usage to encourage efficiency



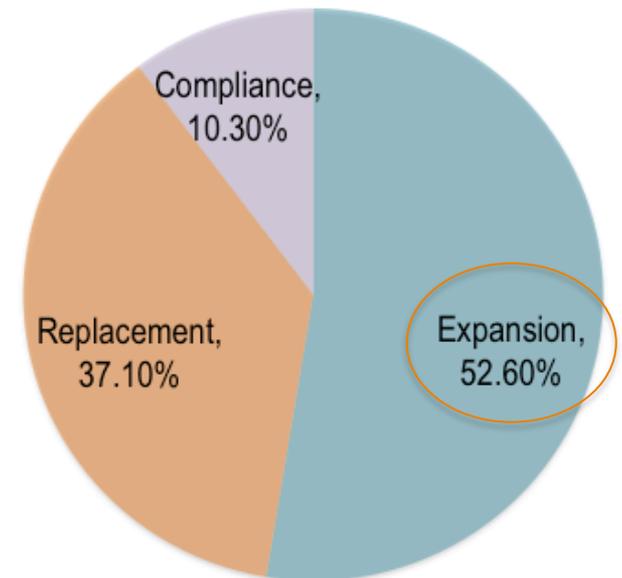
Long-term implications of a “new normal”

- Water demand could become more stable and predictable and should eventually find a new normal or new equilibrium (35-45 gpcd?)
 - ▶ The wild card remains outdoor use in relation to weather and climate but cultural efficiency gains there will change the water game
- Benefits of stable and efficient (“low”) water usage to utilities
 - ▶ Demand forecasting becomes easier
 - ▶ Weather and climate becomes less determinative
 - ▶ Rate design becomes less determinative
 - ▶ Customer bills (revenues per customer) flatten
 - ▶ Securing financial capital becomes easier
 - ▶ Hedging (for revenue instability) becomes unnecessary
- In other words, revenue stability can be achieved over time with sound pricing and increased end-use efficiency

Re-optimizing water and wastewater systems

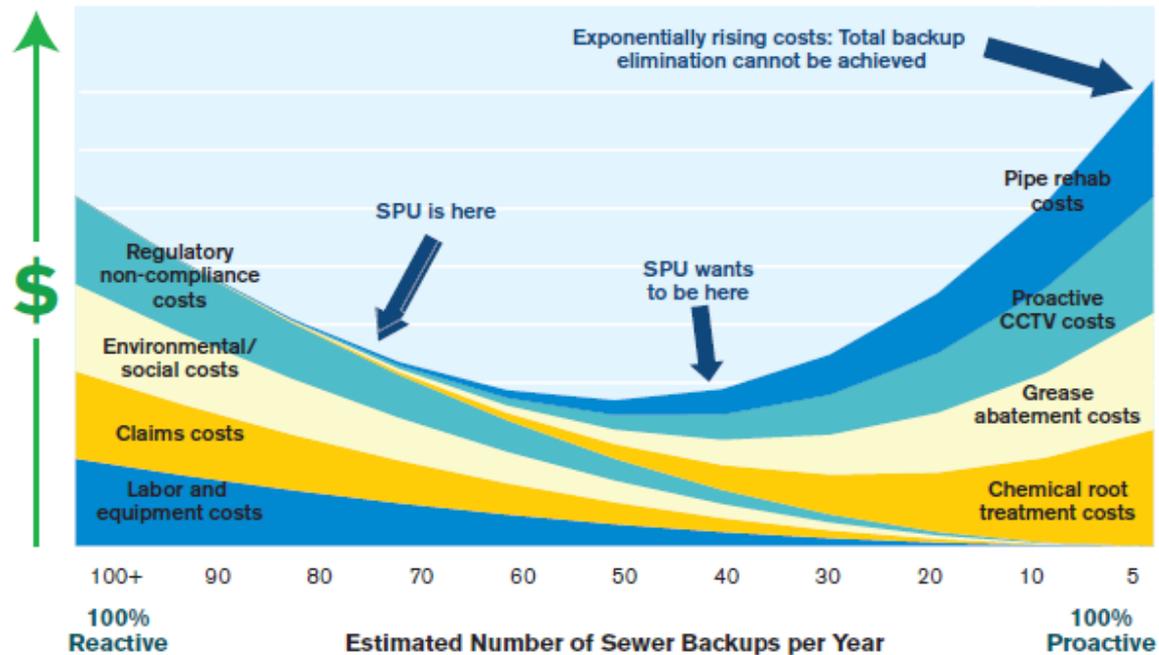
- Don't build tomorrow's water systems to meet yesterday's water demand
 - ▶ Failure to capture avoided costs in system design negates benefits of efficiency
 - ▶ Optimization includes all functions (production, distribution, storage, and energy management)
 - ▶ Public systems may underinvest while private systems may overinvest (AJ effect)
 - ▶ Both need to guard against risk of imprudent or stranded investment from "expansion"
 - ▶ Assumptions about replacement should be scrutinized and cost recovery should not be automated
 - ▶ Supply augmentation (desalination and gray-water systems) should be carefully evaluated

Water industry capital expenditures
(EPA, CWSS 2006)



Strategic infrastructure planning

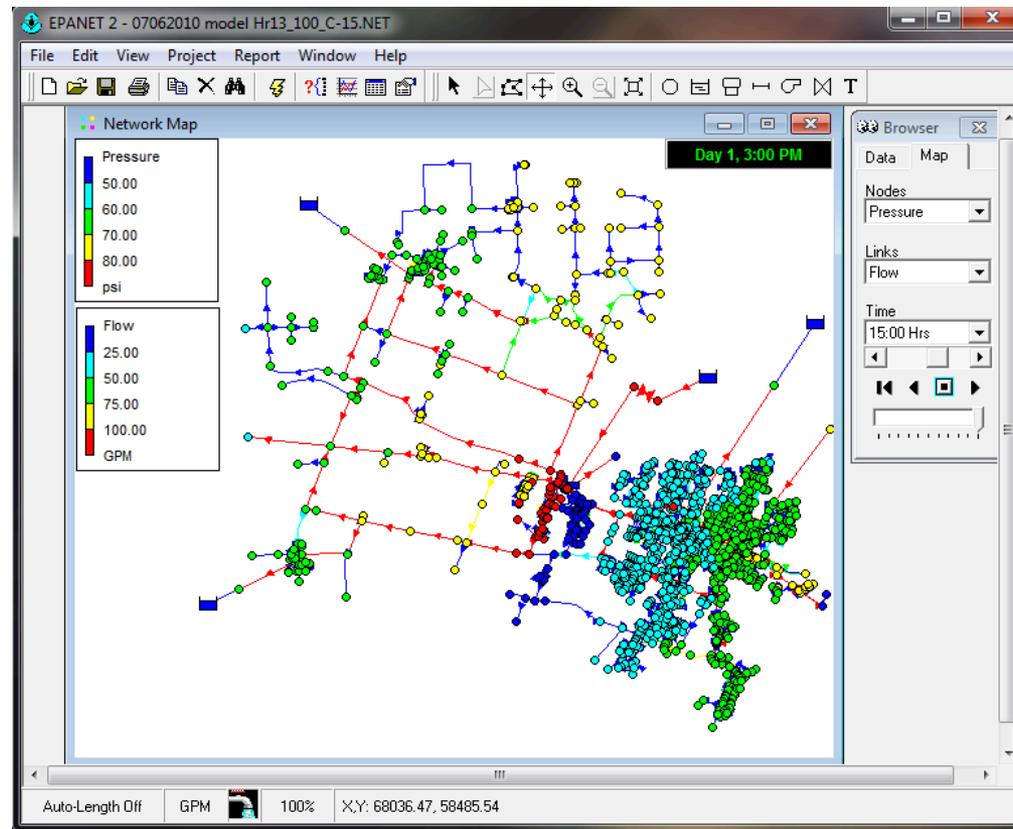
- It may be imprudent to replace all pipes pre-emptively (Seattle)
- Some systems practice watchful “run-to-failure” for some infrastructure
- Water differs from natural gas on this issue for obvious safety reasons



Source: Seattle Public Utilities

System optimization modeling

- Water systems benefit from capital planning and asset management
- Advanced modeling can identify pipes to upsize, downsize, add, or abandon
- Genetic algorithm optimization model considers water and energy (Optimatics)



Water systems and fire protection

- Water systems are co-generators: one pipe delivers five products (20 tons/mo.)
- Indoor water use could become a byproduct of fire protection and sanitation
- How water is used has implications for rates and rate design

Usage	Gallons/month (four-person household)
Consumption: drinking and cooking	1,000
Personal hygiene: washing and sanitation	1,000
Home hygiene: laundry and cleaning	1,000
Discretionary: irrigation and other outdoor use	1,000 – 3,000
Fire protection	???

Observations

- Efficiency gains appear quite durable with the potential to avoid costs
- Demand may go very low as price elasticities drive discretionary usage down
- Outdoor usage will drive sales and revenue volatility, particularly if underpriced
- Capacity utilization and volatility argue for peak-usage pricing
- Decline has occurred largely without programs, incentives, or “decoupling”
- There is significant potential to avoid operating and capital costs
- Water utilities need to invest in forecasting, modeling, and planning
- Water utilities are not facing a death spiral or existential threat
- Water systems should be re-optimized relative to new normals
- The water sector can lead the way from a growth to a sustainability paradigm

Data request for further research

- Long time series of data
 - ▶ Customer sales by class
 - ▶ Number of customers by class
- Rate history data
- Programs, codes, and policy changes
- Demographic data
- Other relevant information

Thank you!



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October 27-31, 2014 | Sand Key | Clearwater Beach, FL
Hands-on rate-case training sponsored by the NARUC Committee on Water.
[More Information](#) | [Register](#) | [Fax-in Form](#)

Michigan Forum on Economic Regulatory Policy
January 30, 2015 | Kellogg Center | East Lansing, MI
A one-day seminar for policymakers and stakeholders focusing on Michigan regulatory issues in telecommunications and energy within the changing national context.
[More Information](#) | [Register](#) | [Fax-in Form](#)

2015 Grid School
March 9-12, 2015 | Chicago Marriott Oak Brook | Oak Brook, IL
An objective and rigorous overview of electricity grid for the regulatory policy community focusing on technical, economic, and policy issues and taught by knowledgeable academic faculty and technical experts.
[More Information](#) | [Register](#) | [Fax-in Form](#)

Western NARUC Utility Rate School
May 11-15, 2015 | Coronado Island | San Diego, CA
Hands-on rate-case training sponsored by the NARUC Committee on Water