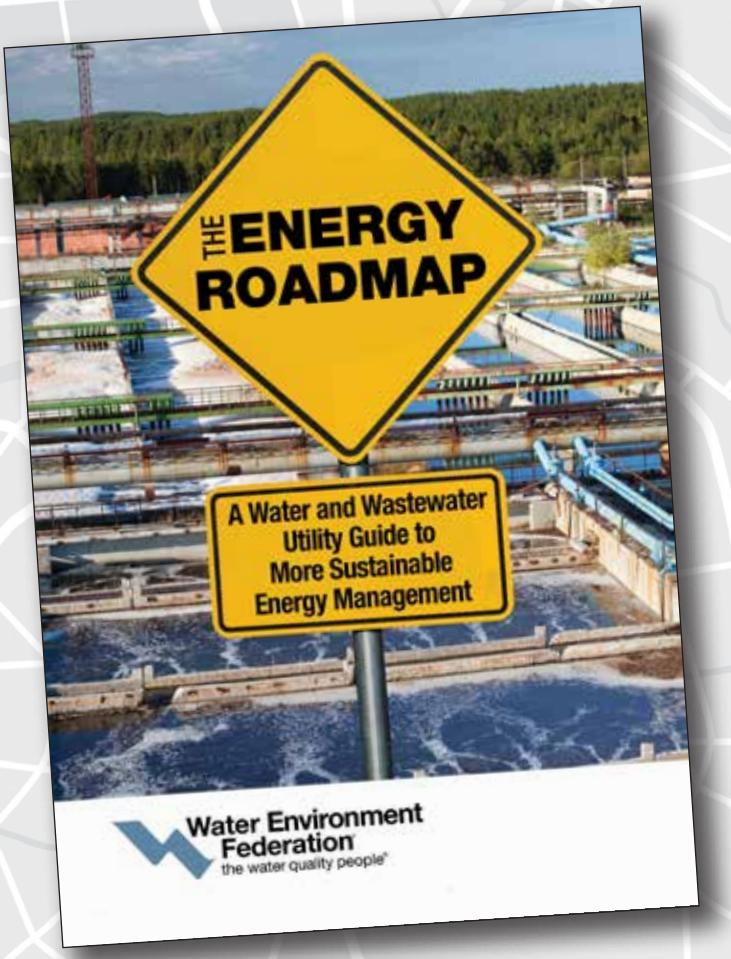
The Energy Roadmap

PRIMER

A preview of more sustainable energy management



"Wastewater treatment plants are not waste disposal facilities but are Water Resource Recovery Facilities that produce clean water, recover nutrients (such as phosphorus and nitrogen), and have the potential to reduce the nation's dependence on fossil fuels through the production and use of renewable energy."

— Water Environment Federation 2011 Renewable Energy Position Statement

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Energy sustainability is achieved through a combination of advancements in technical and organizational aspects of a utility. The WEF Energy Roadmap provides a high-level framework upon which to build an energy sustainability program. The practices and characteristics are arranged under six topics:

- Strategic Management
- Organizational Culture
- Communication Outreach
- Demand Side Management
- Energy Generation
- Innovating for the Future

Under the six topics, the steps are organized into levels of progression. The first set of steps enables the organization. The second set integrates energy efficiency and generation into the organization's structure, culture, communications strategy, and technology. The last set of steps involves optimizing current processes and procedures.

- Strategic Management: High-level management policies and practices that lay the foundation for sustainable energy management
- Organizational Culture: Implementation of an energy vision to create an organizational culture that values energy efficiency at all levels and supports an energy champion and cross-functional energy team
- Communication and Outreach: Tools for effective two-way communication with key stakeholders around energy management
- Demand Side Management: Methods to assess and reduce energy use and energy costs
- Energy Generation: Tools for utilities to evaluate whether and how to increase onsite renewable energy production and/or investments
- Innovating for the Future: Guidance for utilities of all sizes to leverage existing research, further in-house innovation and manage risk associated with these ventures

The progression towards the utility of the future is based on a process of continuous improvement. Not all facilities will become "power positive," nor should they expect to. The three levels of progression within each topic areas are defined as:

- Enabling: Planning process, including initiating first steps and launching program components
- Integrating: Implementation process, including establishing a framework to make widespread adoption within the utility successful
- Optimizing: Further enhancing and fine-tuning improvements and spreading them outside of the utility

Better Buildings®
U.S. DEPARTMENT OF ENERGY

Fact Sheet

WASTEWATER INFRASTRUCTURE ACCELERATOR

The **Better Buildings Initiative** is a national leadership initiative calling on state and local officials, corporate chief executive officers, university presidents, utilities, and other leaders to make substantial commitments to improve the energy efficiency of their buildings and plants, save money, and increase competitiveness. The cornerstones are a commitment to a 20% or more savings target across the organizations' portfolios and a commitment to share strategies that work, substantiated by energy data across the portfolios. The U.S. Department of Energy (DOE) is expanding this initiative to engage leaders in a set of **Better Buildings Accelerators** designed to demonstrate specific innovative approaches, which upon successful demonstration will accelerate investment in energy efficiency.

The **Wastewater Infrastructure Accelerator** will work over three years with state, regional, and local agencies that are engaging with water resource recovery facilities in their jurisdiction to accelerate a pathway toward a sustainable infrastructure of the future. This DOE initiative will build upon and leverage a substantial portfolio of work, resources and partnerships established by the U.S. Environmental Protection Agency (EPA) and various industry partners to add a new set of partners focused on developing actions and solutions in the energy-water nexus. DOE recognizes EPA's Office of Wastewater Management (OWM) leadership and will coordinate with EPA and this growing coalition on approaches to assist Accelerator partners chart pathways to sustainability.

The Accelerator aims to catalyze the adoption of innovative and best-practice approaches in data management, technologies, and financing for infrastructure improvement. Wastewater Infrastructure Accelerator Partners will seek to improve the energy efficiency of their participating water resource recovery facilities by at least 30 percent and ideally integrate at least one resource recovery measure. Partner solutions will provide model plans and road-tested examples that other water resource recovery facilities can follow on their path to a sustainable wastewater infrastructure.

Goals of Wastewater Infrastructure Accelerator

- Demonstrate best-practice/cutting-edge approaches and tools toward a sustainable wastewater infrastructure and yield road-tested examples for other facilities
- Document model plans for transitioning to a sustainable infrastructure that will help drive more solutions in the industry
- Develop assessment and decision tools for selecting best-practice approaches and tools on the pathway toward a sustainable infrastructure
- Develop recommendations for post-Accelerator next steps

Why Reducing Energy in Water Resource Recovery Facilities is Important

Wastewater contains about five times more energy than is needed for its treatment,[1] resulting in a total annual energy use by municipal wastewater treatment systems in the U.S. of approximately 30 billion kWh.[2] Energy operations are typically the largest consumers in a community, and reductions in energy usage can yield significant environmental, economic, and social benefits for these communities. The energy use of these systems is expected to increase by up to 20 percent in the coming decades due to more stringent water quality standards and growing water demand based on population growth.[3]

In recent years a growing number of utilities responsible for clean water have been moving from strict wastewater treatment to water resource management, some formally renaming themselves water resource recovery facilities. Energy efficiency in equipment, processes, and operations is a fundamental part of this transition, and energy savings in facility retrofits can reach 50 percent. Facilities can expand this energy-efficient foundation with resource recovery measures to move closer to a sustainable wastewater infrastructure. DOE will help accelerate their movement toward this goal.

Learn more at betterbuildingssolutioncenter.energy.gov

U.S. DEPARTMENT OF ENERGY

WEF fully supports the goals of the Department of Energy's Better Buildings Initiative and the Wastewater Infrastructure Accelerator and hopes that this WEF Energy Roadmap Primer and suggested resources help Accelerator participants on their journey to energy sustainability.

Benefits to Accelerator Partners:

- **Tools and Resources**

  Access tools, resources, and options for measuring results, operationalizing efficiency and sustainability goals, and funding transition to a sustainable wastewater infrastructure.

- **Technical Expertise**

  Access and leverage technical expertise developed in DOE technology offices, EPA, and other organizations. The sources and analysis available from these organizations will support assessment of technical options and how to package them on the path to a sustainable infrastructure.

- **Model Solutions**

  Collaborate with industry peers and stakeholders to create model solutions for technical and financing needs on the path to a sustainable infrastructure.

- **National Recognition**

  Receive national recognition from DOE for demonstrating commitment to pursuing a pathway to a sustainable infrastructure, developing road-tested examples for other water resource recovery facilities to use, and raising the visibility of efficiency and sustainability efforts with employees, community, and stakeholders.

Accelerator Partner Agrees To:

- **Recruit** one or more water resource recovery facilities in the jurisdiction that are committed to reducing their energy consumption, as measured by overall energy intensity, by 30 percent; and provide a point of contact at each
- **Participate** in peer exchange and technical assistance forums about tools, approaches, technologies, and options
- **Develop** a baseline energy consumption within six months
- **Demonstrate** at least a five-percent energy savings in each facility by applying low- or no-cost energy conservation measures; in at least one of the facilities, implement one or more measures included in the final plan within 12-18 months of the end of the Accelerator
- **Assist** each participating facility in the development of an infrastructure improvement plan that includes best-practice energy performance tracking, a package of cutting-edge technologies with a focus on resource recovery, and a concrete financing model
- **Share** results and lessons learned with DOE and other Accelerator partners. DOE, in turn, will share these results with EPA and industry associations

The U.S. Department of Energy Agrees To:

- **Appoint** a point of contact
- **Provide technical assistance** and training about energy data management, tools, approaches, technologies, and options
- **Develop** additional technical tools and/or assistance necessary to meet the goals of the Accelerator
- **Create and facilitate** networking and technical peer exchange opportunities with stakeholder organizations and other partners to develop best practices and share innovative solutions
- **Leverage** full set of tools and resources developed by stakeholder organizations and compile best practices and approaches for striving toward sustainable infrastructure
- **Provide national recognition** to Accelerator partners and participating facilities for achieving milestones and for their leadership in working toward a sustainable wastewater infrastructure

For Additional Information, Visit:

- **U.S. Environmental Protection Agency**
  www.epa.gov/aboutepa/about-office-water#wastewater
- **Water Environment Federation**
  www.wef.org

1. NACWA, WEF, and WERF. Towards Energy Neutrality at WRRFs – Results and Findings of Recent Research. April 2, 2014. Page 5.
2. EPRI and Water Research Foundation. Electricity Use and Management in the Municipal Water Supply and Wastewater Industries. November 2013. Page ix.
3. Ibid. Page ix.

The Energy Roadmap Matrix

Strategic management–utility progression characteristics.

	Enable	Integrate	Optimize

Strategic direction	SET GOALS
	• Energy goals and key performance indicators are established for both conservation (see *Demand-Side Management*) and production (see *Energy Generation*).
		GATHER SUPPORT
		• Utility incorporates energy goals and key performance indicators to strategic plan.
		• Governing board establishes energy/ sustainability committee.
			PRIORITIZE AND IMPLEMENT
			• Energy management program initiatives are prioritized using tools such as
			  • Strategic business planning and effective utility management and
			  • Environmental management systems.
			• Energy generation is an integral part of a utility's suite of services.
			• Utility implements ISO 50001 Standard.
			• Utility uses triple bottom line approach for sustainability project decision making.

Financial viability	IDENTIFY FUNDING OPTIONS • Financial strategy developed to support energy audit and to fund resulting projects.	BUDGET FOR SUCCESS • Life cycle analysis used for decision-making on energy projects. • Energy use is considered on all capital project design and in operating budget decisions and standard operating practices.	INVEST IN THE FUTURE • Utility's energy initiatives generate sufficient revenue to invest in other utility priorities and reduce upward pressure on rates. • Energy arbitrage opportunities are leveraged.
Collaborative partnerships	EVALUATE OPPORTUNITIES • Opportunities for collaboration on energy projects (e.g., energy services company, joint venture, public– public/ private partnership) are analyzed. • Diverse markets for energy products are identified.	ESTABLISH CONNECTIONS • Contracts with partners are in place and implemented to facilitate data exchange and planning with water, energy, and gas utilities. • Utility planning efforts are integrated with other agencies regarding multiple resources (e.g., water, stormwater, etc.).	LEVERAGE RESOURCES • Utility uses partnerships to maximize energy sales revenues and/or reduce demand (e.g., selling power or biogas to adjacent facility, working with a feedstock provider for co-digestion).
Toward carbon neutrality	PLAN CARBON FOOTPRINT ANALYSIS • Approach to carbon footprint analysis/GHG inventory is established.	INVENTORY GHG* EMISSIONS • Carbon footprint/GHG inventory is developed.	RECOVER RESOURCES • Additional resources are recovered or realized (e.g., carbon credits) as utility moves toward carbon neutrality. • Comprehensive carbon footprint/GHG inventory is maintained, including fugitive emissions and embodied energy of significant inputs (e.g., chemicals).

*GHG = greenhouse gas.

Organizational culture–utility progression characteristics.

	Enable	Integrate	Optimize
Energy vision	DEVELOP VISION • Leadership group develops energy vision. • Governing body adopts energy vision as policy. • Leadership group communicates energy vision to workforce.	COMMUNICATE INTERNALLY • Leadership group links energy vision to staff performance plans. • Leadership group incorporates energy goals/key performance indicators to strategic plan.	COMMUNICATE EXTERNALLY • Utility shares energy vision with external stakeholders and the industry. • Plans are in place to embrace external market changes.
Energy team	FORM TEAM • Utility establishes cross-functional energy team. • Leadership group establishes clear charge and authority for energy team with defined roles for members.	TAKE ACTION AND TRACK • Energy team drives implementation of recommendations. • Energy team systematically reports on progress and future actions.	EMPOWER TEAM • Energy team provided significant budget authority to implement improvements. • Energy team interfaces directly with governing body to get direction from and report on energy program status.
Staff development and alignment	SET TRAINING PLAN • Employee performance plans include energy program-related activities to support energy vision. • Training needs for utility leadership and staff are identified.	TRAIN AND SUPPORT STAFF • Staff are trained in demand-side management and energy generation. • Staff maintains knowledge of emerging technologies through information-sharing events.	EMPOWER STAFF • Leadership group establishes incentives for energy-conservation results. • Leadership group empowers staff to make changes for energy savings.

Communication and outreach–utility progression characteristics.

	Enable	Integrate	Optimize
Customers and community	• Customer outreach and education strategy is tailored to project needs and customer expectations. • Community groups are identified for outreach to gain program support.	• Proactive customer outreach program (e.g., bill inserts, tours, fact sheets, Web site) that focuses on environmental benefits and cost-effectiveness is established.	• Utility engages customers in helping to achieve energy program goals (e.g., local grease collection).
Regulatory and legislative	• Key regulators are identified and effective working relationships are established (e.g., regulations pertaining to air and solids). • Legislative strategy is developed to enhance opportunities and minimize hurdles for energy program.	• Key regulators are educated on holistic energy/water relationship. • Utility advocates for unified regulations that address cross-media issues. • Regional collaboration with other agencies occurs (e.g., for funding or policy changes).	• Utility works with industry associations to influence regulators/legislature to create incentives to encourage efficient energy use and increase renewable energy production. • Utility influences funding agencies to prioritize energy projects in the water sector. • Regulators and utility work together to resolve cross-media issues.
Media outreach	• Media outlets are identified and strategies are developed.	• Media kit is developed (e.g., video, sound-bites, pictures, and press releases).	• Dedicated utility staff work on messaging with media.
Environmental advocacy groups	• Outreach strategy is developed to support energy projects. • Appropriate partnerships are identified.	• Utility shares energy program activities (e.g., tours, fact sheets, etc.).	• Joint programs and outreach that support the goals of both organizations are implemented.
Water sector	• Key energy staff network at local/regional industry events and information-sharing groups.	• Successes, failures, and lessons learned are shared at industry events.	• Energy staff lead industry initiatives to support sector advancements in sustainability.

Demand-side management–utility progression characteristics.

	Enable	Integrate	Optimize

Electricity costs and billing	GET ORGANIZED
	• Historical electric bills are analyzed (2-plus years of data are preferred).
		UNDERSTAND THE DETAILS
		• Rate structure and billing details are understood
		  • Demand charges
		  • Energy charges, unit costs, and time of use
		  • Billing period
			IMPLEMENT CHANGES
			• Modifications are made to billing and/or operations to reduce costs
			  • New rate structure is selected and
			  • Loads are shifted to reduce on-peak demand charges or unit costs.

Power measurement and control	GET THE BIG PICTURE • Baseline energy use and benchmarks are determined. • Energy submetering needs are identified. • SCADA[a] systems and power monitoring capabilities are identified.	DETERMINE USE BY KEY PROCESS • Energy use by each significant unit process area is determined. • Energy use is benchmarked against similar size/type plants to identify target areas for energy reductions. • Electricity use and process data are analyzed together. • Load management (shedding/switching) is in place.	MONITOR FOR REAL-TIME CONTROL • Electricity use by significant load center is monitored in real time. • Real-time control is in place (e.g., SCADA) to measure equipment energy use and efficiency with a user-friendly display (i.e., “energy dashboard”). • Excess power generation is wheeled to other assets or entity.
Energy management	INITIATE AUDIT • Energy team performs energy audit. • Goals are set for reducing energy use and costs.	IMPLEMENT RECOMMENDATIONS • Cost-effective recommendations from audit are implemented. • Energy team tracks actual vs planned results.	PLAN FOR THE FUTURE • Energy savings are incorporated to the design of all future capital projects and new operating strategies.
Source control	UNDERSTAND INFLUENT • Loads (industrial, water use, I&I[b]) are understood and evaluated for energy treatment requirements and energy production potential.	MANAGE LOADING • Methods are in place to manage influent loading to reduce energy use (e.g., industrial surcharge optimization, I&I reduction program, etc.). • Methods to reduce flows are investigated.	ENHANCE ENVIRONMENT • Sources are managed to reduce energy use and maximize energy production potential (e.g., appropriate incentives for trucking high-strength waste).

[a]SCADA = supervisory control and data acquisition and

[b]I&I = infiltration and inflow.

Energy generation–utility progression characteristics.

	Enable	Integrate	Optimize
Strategy	SET PRODUCTION GOAL • Measurable energy generation goal is established. • Energy generation plan is coordinated with utility strategic plan. • Energy team understands regulatory and permit limitations (e.g., air emissions) with regard to generation.	OBTAIN SUPPORT • Governing body approves capital budget for energy generation projects. • Regulatory issues have been addressed and satisfactorily resolved.	GROW PROGRAM • Infrastructure for energy generation is proactively maintained, renewed, and upgraded. • Holistic evaluation methodologies (e.g., triple bottom line) are used to evaluate energy generation opportunities.

Energy from water	EVALUATE INTEGRAL ENERGY SOURCES
	• Available energy resources are quantified, such as
	  • Biogas,
	  • Hydropower, and
	  • Heat.
		IMPLEMENT GENERATION SYSTEMS
		• Energy generation facilities are operating and producing power/heat for utility use
		  • Electricity/heat and
		  • Fuel (natural gas, pellets, etc.).
			OPTIMIZE PRODUCTION
			• Energy production is optimized to maximize the value of generation (e.g., biogas storage to offset power purchases during on-peak hours).

Supplemental energy sources	IDENTIFY SUPPLEMENTAL ENERGY SOURCES
	• Available non-water-derived energy sources are quantified, including
	  • Co-digestion,
	  • Solar, and
	  • Wind.
	• Feedstock market evaluation is performed.
		IMPLEMENT GENERATION SYSTEMS
		• Energy generation facilities are operating and producing power/heat or fuel.
		• Quantity and quality of feedstock meets capacity.
			MAXIMIZE PRODUCTION
			• On-site electricity generation from all sources approaches or exceeds on-site electricity demand.
			• High-strength organic waste (e.g., food; fats, oils, and grease; etc.) is integrated into feedstock supply to increase generation potential.

Renewable energy certificates (RECs)	PLAN FOR RECs • Staff gain understanding of state regulations for renewable portfolio standard and production and sales of RECs.	USE RECs • Utility produces, sells, and/or purchases RECs, as appropriate.	MAXIMIZE VALUE OF RECs • Sales and purchases of RECs are optimized to maximize value of resources, potentially using automation.

Innovating for the future–utility progression characteristics.

	Enable	Integrate	Optimize
Research and development (R&D)	PREPARE FOR R&D • Staff are well versed in existing technologies. • Opportunities are identified by survey of emerging technologies.	PERFORM R&D • Utility budget includes R&D funding. • Utility actively participates in water innovation partnerships (e.g., water innovation centers, research foundations, university partnerships, etc.).	EXPAND R&D • Utility culture is open to new technologies. • Site visits to facilities using innovative technologies occur regularly. • Completed trials and research projects provide the foundation for further advancement within the industry.
Risk management	IDENTIFY AND PRIORITIZE RISKS • Risk of innovation is identified. • Strategy for risk mitigation is developed. • Planning includes measures for climate change adaptation (e.g., extreme events).	MITIGATE RISKS • Risk is reduced through collaborative research and information sharing. • Leadership group recognizes and rewards innovative approaches.	LEVERAGE INNOVATION • Organization can successfully trial and implement innovative projects and is adaptable to emerging opportunities. • Patents are obtained to protect utility and water sector.
Alternative treatment technologies	EVALUATE TECHNOLOGIES • Technologies that reduce energy use or increase generation are identified.	INITIATE TRIALS • Advanced low-energy treatment technologies and energy production technologies are demonstrated.	IMPLEMENT FULL-SCALE SOLUTION • Lower energy-consuming processes replace energy-intensive secondary treatment.
Alternative management approaches	IDENTIFY ALTERNATIVES • Decentralized treatment options are considered. • Planning is performed on a watershed basis.	IMPLEMENT ALTERNATIVES • Green infrastructure projects are implemented where appropriate. • Enhanced regionalization (e.g., biosolids processing) has been considered and implemented where appropriate.	EXPAND INTEGRATION • Alternative management approaches (e.g., decentralization, regionalization, etc.) are used, where appropriate, to maximize overall, regionwide benefit.

WEF Energy Roadmap to ISO 50001 mapping

Overview of ISO 50001–Energy Management

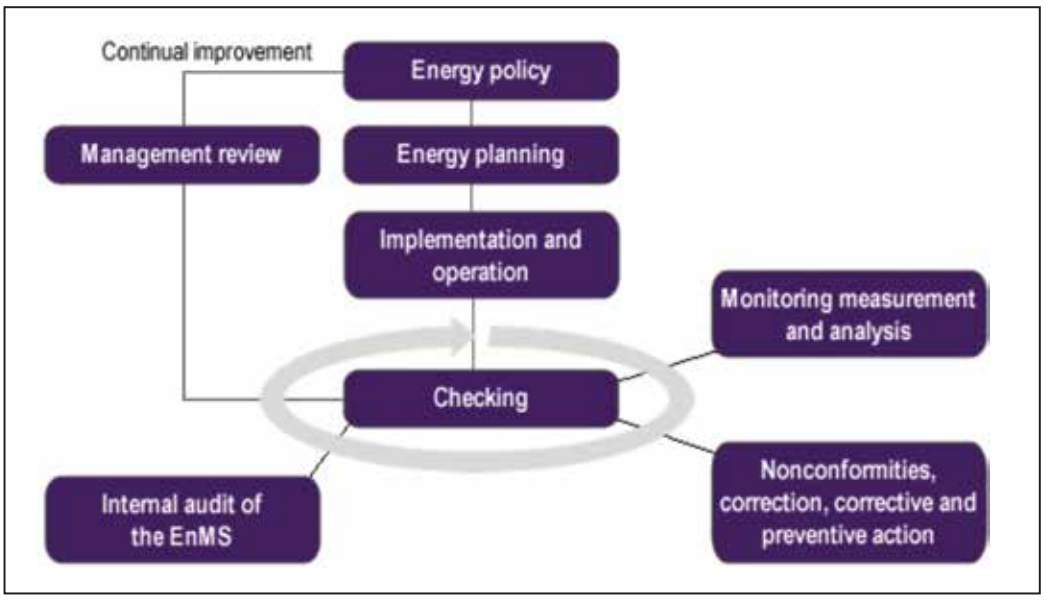
This standard, published by the International Organization for Standardization in 2011, is applicable to all types and sizes of organizations, regardless of geographical, cultural, or social conditions. It is appropriate for use by the water sector and complements *The Energy Roadmap*. ISO 50001–Energy Management is designed to be used either independently or in alignment with another management system, such as this guidance document. Successful implementation of *The Energy Roadmap*, ISO 50001, or both depends on commitment from all levels and functions of the organization, especially top management.

The purpose of ISO 50001 is to enable organizations to establish the systems and processes necessary to improve energy performance, including energy efficiency, use, and consumption. The standard is intended to lead to reduced environmental effects (including reductions in greenhouse gas emissions) and energy cost savings through systematic management of energy.

ISO 50001 specifies requirements for an energy management system upon which an organization can develop and implement an energy policy and establish objectives, targets, and action plans. ISO 50001 applies to activities under the control of the organization, and application of the standard can be tailored to fit specific requirements of the organization, including the complexity of the system, degree of documentation, and resources. The "plan-do-check-act" continual improvement framework is used to incorporate energy management to everyday organizational practices, as the preceding graphic shows.

To simplify mapping of key elements in *The Energy Roadmap* to the clauses in ISO 50001, topics, themes, and progressions are represented in abbreviated fashion as follows: *SM-SD* stands for the strategic management topic area and the strategic direction theme. In instances where a specific characteristic or activity is referenced, the numbers 1, 2, and/or 3 will be appended. For example, *OC-EV23* stands for organizational culture topic, energy vision theme, progressions 2 (integrate) and 3 (optimize). Where no numbers are used, the ISO 50001 clause encompasses all three levels of progression in the theme. Topic areas and theme abbreviations are presented in Table A.1.

Table A.2 shows mapping between *The Energy Roadmap* elements and the ISO 50001 clause. Where ISO 50001 has a subclause denoted by a letter, that letter is listed after the applicable *The Energy Roadmap* element. For example, *OC-EV (a)* in ISO 50001 clause 4.2.1 means that the *The Energy Roadmap* element "Organizational Culture" and topic "Energy Vision" addresses ISO 50001 clause 4.2.1(a).



Source: ISO 50001–Energy Management (ISO, 2011); Introduction, pp. v–vi.

Table 1 Topic areas and theme abbreviations.

Topic area	Themes
• SM–Strategic Management	• SD–Strategic Direction • FV–Financial Viability • CP–Collaborative Partnerships • TCN–Toward Carbon Neutrality
• OC–Organizational Culture	• EV–Energy Vision • ET–Energy Team • SDA–Staff Development and Alignment
• CO–Communication and Outreach	• CC–Customers and Community • RL–Regulatory and Legislative • MO–Media Outreach • EAG–Environmental Advocacy Groups • WS–Water Sector
• DSM–Demand-Side Management	• ECB–Electricity Costs and Billing • PMC–Power Measurement and Control • EM–Energy Management • SC–Source Control
• EG–Energy Generation	• S–Strategy • EWW–Energy from Water and Wastewater • SES–Supplemental Energy Sources • REC–Renewable Energy Certificates
• IF–Innovating for the Future	• RD–Research and Development • RM–Risk Management • AT–Alternative Technologies • AM–Alternative Management

Table 2 *The Energy Roadmap* crosswalk with ISO 50001– Energy Management.

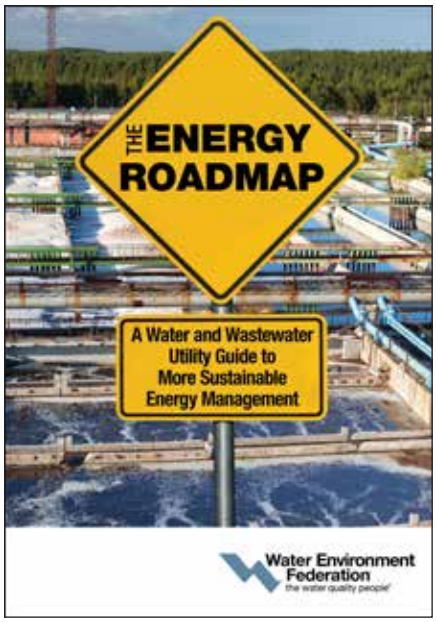
ISO 50001 clause	Criteria	*The Energy Roadmap* topic/theme/ progression
4.1	General requirements	SM-SD OC-EV
4.2	Management responsibility	No clauses
4.2.1	Top management	OC-EV (a) OC-ET (b) OC-SD (c) SM-FV (c) SM-SD (d, f, g) OC-EV2 (e, i) SM-FV2 (h) SM SD3 (j)
4.2.2	Management representative	OC-ET12 (a, b) OC-ET2 (c, d) SM-SD2 (e) OC-ET1 (f) SM-SD3 (g) OC-SDA (h)
4.3	Energy policy	SM-SD (a, h) DSM-PMC (b) SM-FV (c, f) OC-SDA3 (c) SM-CP (d) SM-SD3 (e) EG-REC (f) OC-ET23 (g)
4.4	Energy planning	No clauses
4.4.1	General	SM-SD
4.4.2	Legal requirements and other requirements	CO-RL EG-S2
4.4.3	Energy review	DSM-ECB12 (a) DSM-EM1 (a) EG-EWW (a) EG-SES (a) DSM-PMC (b) DSM-EM (c)
4.4.4	Energy baseline	DSM-PMC
4.4.5	Energy performance indicators	DSM-PMC EG-S

Table 2 *The Energy Roadmap* crosswalk with ISO 50001– Energy Management. (continued)

ISO 50001 clause	Criteria	*The Energy Roadmap* topic/theme/ progression
4.4.6	Energy objectives, energy targets, and energy management action plans	DSM-PMC DSM-EM SM-SD1 EG-S
4.5	Implementation and operation	No clauses
4.5.1	General	DSM-EM2 EG-EWW23 EG-SES23
4.5.2	Competence, training, and awareness	OC-SDA (a, b, c, d) OC-EV (a)
4.5.3	Communication	OC-EV2 (internal communications) OC-EV3 (external communications) CO (external communications)
4.5.4	Documentation	SM-SD
4.5.5	Operational control	DSM-PMC (a, b, c)
4.5.6	Design	DSM-EM3 SM-FV2
4.6	Checking	No clauses
4.6.1	Monitoring, measurement, and analysis	DSM-PMC (a, b, c, d, e)
4.6.2	Evaluation of compliance with legal requirements and other requirements	EG-S2 CO-RL
4.6.3	Internal audit of the EnMS*	Procedural aspect of ISO standard not specifically covered by the guidance document
4.6.4	Nonconformities, correction, corrective action, and preventive action	Procedural aspect of ISO standard not specifically covered by the guidance document
4.6.5	Control of records	Procedural aspect of ISO standard not specifically covered by the guidance document
4.7	Management review	No clauses
4.7.1	General	SM OC
4.7.2	Input to management review	Procedural aspect of ISO standard not specifically covered by the guidance document
4.7.3	Output from management Review	Procedural aspect of ISO standard not specifically covered by the guidance document

*EnMS = energy management system.

Resources



The Energy Roadmap

The Energy Roadmap serves as a guide for utilities of all sizes on the path to sustainable energy management. In it, you will explore innovative approaches to cost-effectively recover and reuse resources to transform "wastes" to valuable products. The book outlines six stops on the path to resource recovery, presenting insights and models for

1. strategic management,
2. creating an organizational culture,
3. effective communication and outreach,
4. demand-side management,
5. energy generation, and
6. innovating for the future.

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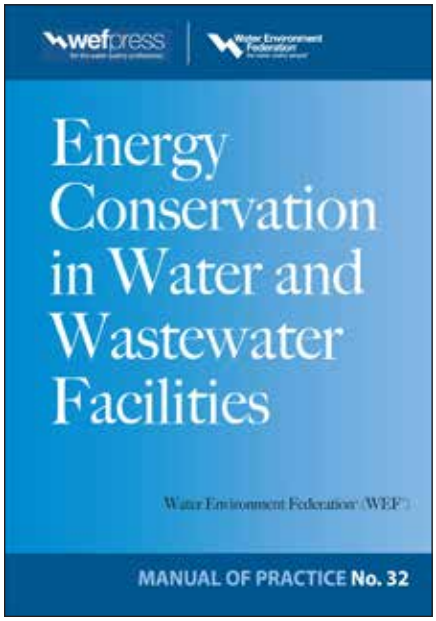

Energy Conservation in Water and Wastewater Treatment Facilities, MOP 32

Covering water and wastewater treatment, this manual discusses principles and concepts of energy requirements, potential sources of inefficiency, and recommended energy conservation measures for specific equipment and processes. The manual addresses utility billing procedures and incentives as well as energy considerations for electric motors and transformers, pumps, variable controls, aeration systems, blowers, and solids processes.

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