Preface

The Guide to Energy Management (GTEM) was written with the intent to raise the bar for how demand side energy and carbon management (DSM) is done in practice. The scope of this book, as described in more detail in Chapter 1, focuses on the demand side ("behind the meter") of energy systems for residential, commercial/institutional, and industrial facilities. While the supply side of energy systems ("front of meter") is also very important, it is generally not in the scope of this book. Similarly, some demand side applications such as transportation (cars, freight, air travel, shipping) are equally important, but not in scope. The GTEM will be most valuable for educators, learners, and practitioners in the U.S. and Canada, and it should also be useful in any higher-income context with modern energy systems. Key themes in the GTEM that make it relatively unique as a DSM resource are as follows:

1. **Climate change is real and the speed and scale of climate action needs to increase.** The current science of climate change is strongly conclusive that achieving net-zero GHGs is a prerequisite for the Earth system to ever realize a stable climate, and that negative emissions will eventually be needed to reverse the cumulative warming that has occurred since pre-industrial times (see Chapter 2). Furthermore, mitigation alone is insufficient because adaptation (see Chapter 8) is now essential (and some argue to consider solar radiation management as well). Today there are many in society who recognize the need to take urgent action to solve climate change, and there are also many who do not. No matter the rationale stated to perpetuate inaction (e.g. those who claim to be dismissive, disengaged, doubtful or cautious – you can search to learn about Yale's "Six Americas" framework), these stated rationales do not change the robust findings of climate science or nullify the damages to human, economic, and ecosystem health being inflicted from a changing climate. The GTEM includes practical guidance for developing and implementing demand-side climate solutions to support an increase in the speed and scale at which solutions are implemented.

2. **All energy systems are built with connected building blocks in order to deliver services.** Developing effective DSM solutions requires an understanding of how human-built energy systems are generally comprised of six connected building blocks (see Chapter 1). The transition to cleaner energy can be envisioned as a need to reconstruct these connected building blocks for demand-side systems (e.g. see Figure 2.9 vs. Figure 2.10). The GTEM is written from the perspective that all solutions should be developed and implemented with careful attention to maintaining, if not improving, delivered energy services (see Chapters 1 and 3).
3. **People are part of energy systems.** Developing effective DSM solutions requires recognition that people are part of the system. This means, for example, that common practice should be to conduct baseline and post-implementation surveys of facility users and O&M staff interviews (see Chapter 3), think carefully about how to best organize an effective energy team (see Chapter 1), and in general to apply proven behavior change methods (see Chapter 7). Most energy and carbon management teams arguably should include individuals with relevant social sciences expertise, to complement the usual engineering, business, economics, finance, and O&M expertise.
4. **DSM will be more effective by embracing and applying clear definitions for key concepts.** In particular, there are four key concepts: Energy management, energy efficiency, energy conservation, and energy savings (see Chapter 1). There is no benefit, and sometimes unintentional harm, by confusing stakeholders by using the terms "efficiency" and "conservation" interchangeably, or by always assuming energy efficiency means energy savings will be realized (yes, it is true that a more energy efficient system may not result in verified energy savings due to rebound effects and eligibility rules for subsidies). Similarly, clear definitions are important in carbon management (see Chapter 2). Obfuscation is unnecessary and can be an enemy of progress.
5. **Integrated solutions are needed.** Successful DSM initiatives are designed to develop integrated solutions which deliver multiple benefits such as energy savings, GHG reduction, climate adaptation, improved energy equity, and/or reduced air pollution exposures while maintaining or improving delivered services (see Figure 3.1). More often than not, solutions which narrowly focus solely on, say, GHG reduction (or only utility bill savings, or only efficiency, or only adaptation) are less

likely to be funded and implemented by comparison to solutions which realistically offer multiple benefits.

The GTEM is written as an educational resource for professional and university programs and for everyday use by practitioners. Each chapter includes at least five practice problems. Solutions to these practice problems are available in a separate GTEM Solutions Manual. Every chapter is written in a manner aiming to be as useful as possible for practitioners who contribute to the assessment, design, implementation, and maintenance of real-world DSM solutions. All chapter authors were challenged with the task to: a) provide the fundamentals of each topic so that someone new to the topic can understand the basics, and b) additionally provide insights useful for DSM veterans. We think that the GTEM delivers on this challenge.

The GTEM is organized by providing key concepts, definitions, and methodologies mostly in the initial chapters. The basics of energy systems and climate change are provided in Chapters 1 and 2, respectively. No matter what one's role is in DSM, you will likely benefit by knowing something about energy and decarbonization studies (Chapter 3), utility rates (Chapter 4), conventional economics (Chapter 5), finance (Chapter 6), human behavior (Chapter 7), resiliency (Chapter 8), commissioning (Chapter 16), and maintenance (Chapter 21). The remaining chapters (9-15 and 17-20) cover essential technologies including: HVAC, heat pumps, building envelope, lighting, electric systems, motors and drives, controls, electric and thermal storage, solar energy, thermal energy networks, and industrial systems. Collectively, these technology-focused chapters cover the fundamentals for technologies and practices needed for most DSM solutions.

There are no significant prerequisites for using the GTEM effectively. However, having practical experience with real-world DSM solutions will help readers gain more from the material. For the technology-focused content that makes use of engineering sciences (this includes electric power, control theory, heat transfer, fluid mechanics, and thermodynamics), it is assumed that readers have completed high school level algebra, chemistry, and physics.

A common question from readers is: what is the most effective way to use this book, to gain the most from it? The GTEM is a **problem-focused resource.** From this perspective, the best starting point is to clearly define what the problem is for which you want to develop a solution. All solutions likely involve technology of some kind, although some solutions may be more people-focused, e.g. to implement a behavior-change initiative such as SEM. Defining the problem means deciding upon the project objectives, and defining the systems and technologies of interest. Section 3.1.2 and Table 3.1 will be helpful. In general, it is recommended that readers find the time to read the first 8 chapters, Chapter 16, and Chapter 21, as this content is likely relevant for most solutions. Then, depending on what systems or technologies are included or excluded from the scope of your project, the technology-focused chapters 9-15 and 17-20 can be chosen. For example, if your project is focused on a specialized industrial process, then Chapter 20 will be most useful. If the focus is a heat pump conversion for a building, then Chapters 9, 10, and 11 are important. If solar PV is planned, then be sure to read Chapter 18, etc.

The GTEM incorporates both English (Inch-Pound) and SI (metric) units throughout. This means that for each chapter where units are used, both systems are included in the chapter content. However, **not every practice problem, example, table or chart will use both sets of units.** The reason for incorporating both systems of units is because practitioners in the U.S. and Canada (as well as other countries like the UK) often encounter both systems of units, and thus practitioners are essentially forced to work with two systems. Richard Feynman, the 20th century Nobel prize winning physicist, complained over 60 years ago of the "idiocy of all the different units which they use for measuring energy[1]" and advocated for using one system of units and one unit for each variable (e.g. energy, mass, momentum, etc.). Unfortunately, this "idiocy" of using multiple units and two systems of units still exists today. It would be preferable if one system of units could be agreed-upon globally, but the reality is that we remain stuck with two systems.

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We believe it is important to note that the GTEM was written ~100% by humans! Of course, the team of co-authors made use of AI for tasks such as synthesizing information, generating answers to specific questions (which were subsequently verified by the authors), or generating outlines. However, the actual writing of content was not done by AI.

Substantial effort has been made to minimize errors. But expecting zero errors is unrealistic, and so the publisher maintains a website for errata at: https://www.riverpublishers.com/book_details.php?book_id=1532. The

[1]Feynman (1964) "The Character of Physical Law" MIT Press

formula sheet in Appendix A is also freely available https://www.riverpublishers.com/book_details.php?book_id=1532. Any reader who finds significant errors or who wants to provide feedback as to how to help improve the GTEM (we anticipate a 10th edition), please write to the editor/co-author, Eric Mazzi, at mcs@telus.net.

Eric Mazzi, editor/co-author, and the GTEM team of co-authors