Tutorial Title

Identifying & Analyzing Total Lifecycle Energy Footprints in Large & Small Systems

Instructor Team

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Co-Speakers:

Abstract

Sustainability is something we see getting increased attention these days and hopefully for motivation to drive actionable solutions toward more energy-efficient systems and reducing carbon footprints as opposed to simply paying lip service to the need to be more "green" or even mere carbon neutrality (a.k.a. – net zero). It seems most analyses of system energy consumption, whether it be systems physically constrained to a box (big and small from wireless sensor networks and internet of things devices, or WSN/IoT, to large-scale supercomputers) or even widely distributed across geographies (i.e. – cellular networks or utility distributions), tends to focus more on the first-order energy footprint typically associated with the application lifetime, which is very closely related to the operational expenditures (OPEX) of the application use case. Being green from an energy perspective is now becoming green in the economic sense, which is helping to drive massive investment and the switch to a net-zero mentality toward macro energy utilization. If global climate change and the fear of eventual, mass extinction is not motivating enough, then at least cost savings are. A first-order emphasis on system energy consumption is flawed in numerous ways from improper provisioning of resources, both upstream and downstream from main system usage, to inaccurate calculations of energy footprints and therefore a general misunderstanding of the true, lifecycle energy footprint (LEF, a.k.a. – embodied energy) that not only went into producing the system, but also the energy required to support the system at end of life (EOL), whether it be disposal, recycling, or both. Not to mention the miscalculation of energy footprints will also lead to direct errors in calculations for carbon footprints and the "mathematical neutralization" of these real emissions with offsets and credits. This half-day tutorial will first provide some terminology, metrics, and general assessment philosophies for defining the true energy footprint of a design and what aspects must be taken into account to fully and comprehensively articulate the complete embodied energy of a system from cradle to grave. Many different use cases and applications will be explored using examples from a variety of systems from the micro to the macro scale. Once a firm foundation has been set on understanding the true constraints and contributors to the absolute LEF, time will be spent exploring how some commonly disregarded contributors to LEF can be more dramatic than may seem on the surface and review some suggested methodologies for working these factors into more pragmatic analyses. The remaining half of the tutorial will concentrate on defining and applying a systems-of-systems (SoS) model to the assessment of energy footprints. A black-box methodology for incorporating any constituents of a power value chain (PVC) and translating the outputs to a "common currency" of energy (and related) metrics is proposed. This methodology contains an entire modeling/simulation framework for assessing any combination of hardware, software, utilization, regulatory, and even non-technical aspects to translate

what may seem like an impossible scenario of contributors into a common optimization of a system, seen exclusively through the lens of energy efficiency.

Instructor Team Biographies

Brian Zahnstecher is a Sr. Member of the IEEE, Chair (Emeritus) of the IEEE SFBAC Power Electronics Society (PELS), IEEE PELS North America Regional (R1-3) Chair, Power Sources Manufacturers Association (PSMA) Board of Directors (Emeritus) and now Advisory Council, is Co-founder & Chair (Emeritus) of the PSMA Reliability Committee, Co-chair of the PSMA Energy Harvesting Committee, Co-founder & Co-chair of the EnerHarv workshop, and is the Principal of PowerRox. He Co-chairs the IEEE Future Networks (formerly 5G) webinar series and is a founding Co-chair of the IEEE International Network Generations Roadmap (INGR) Energy Efficiency Working Group and has lectured on this topic at major industry conferences. He sits on Advisory Boards of major conferences like Sensors Converge & DesignCon. He previously held positions in power electronics with industry leaders Emerson Network Power (now Advanced Energy), Cisco, and Hewlett-Packard. He has been a regular contributor on power and sustainability topics to the industry as an invited keynote speaker, author, workshop participant, session host, roundtable moderator, and volunteer. He has over 20 years of industry experience and holds Master and Bachelor degrees from Worcester Polytechnic Institute.