

Digital Energy

Prof. Pavol Bauer

The shift towards an energy system based on renewable sources is a shift from a hierarchically controlled system with centralized generation to a system with less controllable fluctuating and distributed energy supply, with electricity as the main carrier of the generated energy. The challenge to create an energy system that is open to diverse emerging and future technologies and organizational forms is fundamental.

A key conceptual step here is **digitization**. It allows us to separately consider technologies that make up the energy system, the organizations, and citizens that make use of the services of the energy system and the mechanisms that govern their interactions. This is a significant step away from the current system where these elements are highly dependent and determined by the constraints of the initial system configuration. Simply put, the transition to variable renewable energy sources poses new challenges and requirements for the organization and control of the energy system, but also offers a great opportunity to build a novel energy system.

The Digital **Energy Framework** is inspired by concepts like energy cells, energy conversion hubs, energy packets, virtualization, and energy communities. It will allow trading, management, control, and organization of physical components by interactions within a digital variant of the energy system, which is flexible as most of its functions are software-defined scientific concepts.

The intelligent **hardware** required for the integration of energy generation, storage, conversion, and transportation into digital energy concepts (inspired by energy cells and energy conversion hubs, among others) is developed and focuses on designing and analysing the intelligent hardware that enables and facilitates the physical formation of digital energy concepts (energy cells, energy conversion hubs, virtualization, energy packets, energy communities) and integrates them in the existing power system. Furthermore, this intelligent hardware enables intelligent algorithms to control and coordinate the energy system and to achieve the desired techno economical and legal and social objectives.

For the interconnected **digital energy technologies** and infrastructure (energy cells, energy conversion hubs, etc.) to achieve sustainability, modularity and intelligence, novel concepts for the generation, conversion, storage and transportation of renewable energy are required. Within the energy cells and energy conversion hubs, it is anticipated that solar energy, electrochemical conversions, power electronic converters, various forms of energy storage and dc links will play pivotal roles to achieve the desired objectives.