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EDITORIAL

The intertwining issues of energy security, environmental protection, and societal development

Petar Sabev Varbanov[1]

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Sustainable development is frequently defined as having three pillars (Klemeš 2015)—environmental, societal, and economic. These pillars—or components, refer to the three kinds of capital in the theory of human wealth—natural, social, and economic capital. The past several years have clearly demonstrated to the world the fragility of the global supply chains for materials and products. The transportation sector—especially for passengers, has experienced a difficult period. The energy commodities market, although having taken some losses, has kept functioning.

However, the development of the world situation in the last half a year has shown that energy supply also cannot be taken for granted. The prospect of supply reduction or a sharp increase in the cost of natural gas has become real. As can be seen from United Nations-related investigations (Arto et al. 2016), the Human Development Index in the economies is closely related to the amount of energy available to them at a reasonable cost. This raises the issue of energy supply security as a key property of a well-functioning economy that enables societal development. In fact, if the economy stops functioning properly, the efficiency of business and industrial processes tends to drop, in turn potentially increasing the adverse environmental impacts of human activities. This can be clearly seen by the asymptotic trend of the curve correlating HDI and energy use in (Arto et al. 2016).

Looking at the issue from the supply side only presents a difficult problem. In the search for the answer, one has to remember that energy systems have two sides, and supply is only one of them. The second side is the energy demand and therein lies part of the mitigation strategy. This view aligns with the previous research and regular statistics showing that a significant share of the primary energy sourced by economies is actually wasted through various conversion processes and their inefficiency. In the example of the USA, which annually publish credible and updated data (LLNL 2022), approximately two-third of the sourced energy ends up wasted and only one-third is allocated to useful products and services.

Taking the balanced view between the supply and demand sides for energy use, the strategy for achieving sufficient energy security can benefit from synergy with further improvements in the efficiency of energy use, reduction in the inherent energy demands of business and industrial processes, and smart use of available local resources—especially waste.

Examples of such elements benefiting local communities can be found easily. Production of food by combining fish and vegetables growing in aquaponics reduces energy up to 30% (Körner et al. 2021) and water consumption up to 90% (Cohen et al. 2018) compared to the standalone processes. In the housing sector, the concept of passive houses is well known and has already been implemented in practice, reducing building energy consumption to a small fraction of that of conventional housing.

There are also potential good practices on the supply side too. The city of Brno, for example, benefits from a well-developed system of municipal waste management, and a large share of the energy for hot water and space heating is sourced from the city waste processing plant (SAKO 2020). At the very least, the year-round hot water supply is powered by this facility for most of the city. An extended care can be taken of the extended waste management on a regional scale (Fan et al. 2021).

A further step in achieving higher efficiency, low environmental footprints and energy security is the smart use of solar irradiation for powering electricity and heating demands in buildings on a seasonal basis. An excellent example of such smart practices is the RESHeat project

✉ Petar Sabev Varbanov
varbanov@fme.vutbr.cz

1 Sustainable Process Integration Laboratory – SPIL, NETME Centre, Faculty of Mechanical Engineering, Brno University of Technology – VUT Brno, Technická 2896/2, 616 69 Brno, Czech Republic

(RESHeat 2021), implemented by a consortium under the coordination of the Cracow University of Technology in Poland. The project partners from several other European countries—the Czech Republic, Italy, Finland, and several Polish SME partners—have joined their efforts to deliver to the market systems for combined photovoltaic–thermal solar capture, supplemented by underground energy storage. The project has the ambition to achieve at least 70% coverage of the building energy needs (Oclon 2021) from renewable sources.

In summary, the strategy to cope with the environmental and energy security challenges has to involve a carefully managed hierarchy of measures. Those should start with the minimisation of the energy needs of the world economies, followed by reuse and recycling of materials, energy recovery, energy valorisation and reuse, and finishing with the harvesting and utilisation of renewable energy. While some of the base technologies and methods for these solutions are already available and mature, others need improvement, and new solutions are still needed. That is especially the case with the need for accounting for the energy use and the embodied footprints of the goods and services in the economy. The successful practical implementation of such a system would require the coordinated use of all means of smart decision-making—big data for the accounting, the Internet of Things for enabling autonomous and distributed activities, as well as Blockchain technologies for ensuring transparency and accountability among the market actors. This defines a very multidisciplinary landscape for the research efforts in sustainability in the coming years.

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