Appearance of End User Needs to Increase Energy Efficiency and Product Reliability

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***Abstract* — The aim of the study - based on domestic and foreign sources - is to show the development possibilities of technical equipment which used in industrial and civil areas in terms of energy efficiency. During the introduction of the topic, this paper will introduce the emerging needs of end users and then present the results of a questionnaire-based needs survey. In a separate subsection, the paper focus on the user-controllable and modifiable modes in a particular operation of technical equipment and the possibilities of cost-effective implementation. After summarizing the results at the end of the study, the paper will discuss the monitoring possibilities of a centralized energy consumption system.**

I. Introduction

The globalized economy of the 21st century is flooding the world with countless cheap products. Many of these products have the property of ever-decreasing quality and longevity. For many, this high level of consumption is meaningless as the resources of our planet are finite. Somewhere we all feel deep inside that this is far from correct. Behind the luxurious way of life of the present society lies a vast mound of garbage which discarded prematurely.

What is the reason that once expensive status symbols end up in a junkyard due to their failure? What is the reason that a new, unused raw materials end up in the garbage dump? How much raw material and energy did they cost to produce. Questions can also be answered in another form of a new question: How long can this wasteful practice continue? It is time to rethink the general approach to modern energy use.

It is very difficult to change the current economic operation, but proposing options for an optional use of resources could be very useful. Many users would be happy to give up the performance of the device if it would increase the life of the equipment they use. There are few appliances with this option - none of the household appliances - although there is a market demand for it and it could be provided at low cost.

II. ENERGY EFFICIENCY

How do we know how energy efficient is a device, a household or a country? The energy intensity of a country's economy is often used as an indicator of energy efficiency - mainly because, at an aggregate level, this indicator is relatively easily available for evaluating and comparing countries. However, in a country with lower energy intensity, high energy efficiency is not necessarily required. For example, a small, service-based country with a mild climate would have a lower intensity than a large industrial-based country with a cold climate, even if the latter country uses energy more efficiently. Similarly, trends towards lower intensity are not necessarily driven by efficiency gains. Therefore, it is important to perform a more detailed analysis that provides insight into the factors influencing final energy consumption trends.

In 2009, the IEA (International Energy Agency) recognized the need for better monitoring of energy efficiency policies. This includes a country-specific analysis of end-uses in the largest sectors: construction, services, industry and transport. Energy efficiency policies are essential to achieve key energy policy goals, such as reducing energy bills, tackling climate change and air pollution, improving energy balance security and increasing energy efficiency. Nevertheless, global political coverage (~ 35%) leaves many opportunities untapped.

Reliable data and indicators on energy efficiency are key to learning about and monitoring the effectiveness of energy efficiency policies, as they show energy demand.

The IEA's statistical analyses show how the final energy consumption of IEA member states is evolving, and the development directions and implementation efficiencies of national energy efficiency policies can also be monitored. [1] The planned and agreed 3% annual efficiency increase has not yet been achieved.

III. CHANGES IN THE ENERGY EFFICIENCY

The declining momentum of global energy efficiency developments is a matter of serious concern. The IEA Energy Efficiency 2019 report examines the reasons for the slow-down, which has serious consequences for consumers, businesses, governments and the environment. [2]. Since 2015, the improvement in global energy intensity has been weakening every year. Demands for heating, cooling, lighting, mobility and other energy services are constantly increasing. The improvement in the energy intensity of the global economy (the amount of energy used per unit of economic activity) is slowing down. [3] The 1.2% improvement in 2018 was around half the average observed since 2010 (Figure 1). The indicator is well below the desired average of 3%. This reflects the relative lack of new energy efficiency policies and the need to strengthen existing measures. [4]

IV. RESULTS

The present study examines household and industrial electrical appliances. Although the presented results do not bring about direct global change, but they show the validity of the research with real data. In this way, it would act as a basis for initiating real improvements.

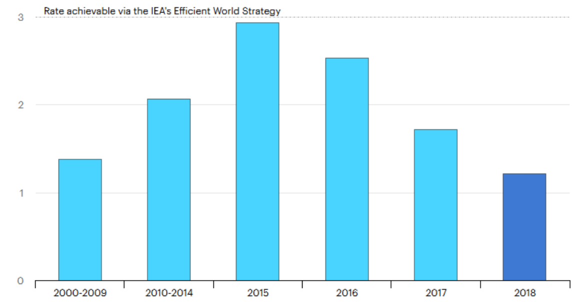

Figure 1. Global improvement in primary energy intensity, 2000-2018 [5]

The respondents to the questionnaires serving as the basis of the research are typically women and men, aged 18-27, who have participated in technical education, or participated before, who are working in technical jobs or have a technical interest. This is the group that will have the greatest influence and value on the selection and / or development of the technical equipment to be procured.

In the questionnaire, respondents were able to answer the questions with integer numbers on a scale from 1 to 5. 1 had the meaning "not important" and 5 had the meaning "very important". There was a gradual transition between the two values.

Respondents were rated for household appliances, consumer electronics, industrial electrical equipment, and electronic systems found in critical infrastructures. The first column (orange) of each category in Figure 2 shows how important respondents con-sider the reliability of electronic systems in a given area; the second column (blue) shows how reliable electronic systems are in the area according to respondents; the third column (lemon yellow) shows how important it is for respondents to increase the reliability of electronic systems in a given field.

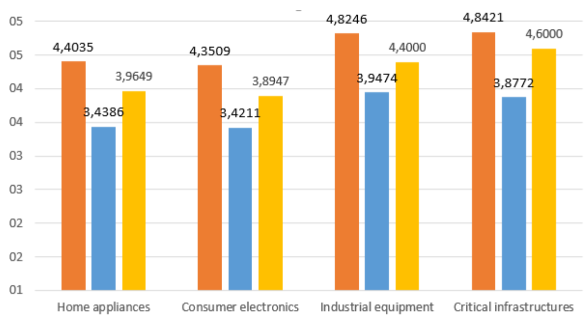

Figure 2. Reliability of electronic systems

The data clearly show that users, in both civil and industrial equipment, need more reliable electronic equipment and systems. This would also be reflected in the solvent de-mand shown in the figure below. End-users would also undertake a price increase of ~ 20-30% in the studied areas if they could use more reliable devices. (It was possible to answer the questionnaire with 10% accuracy.)

Increasing the reliability of civil and industrial electronic equipment is possible at minimal cost. For example: installation of higher quality components, making design changes, changing design and testing principles, installation of minimal cost hardware and software modules, etc. The discussion of long-term sales numbers and sales strategies is not the purpose of this article, but clearly visible the possibility of developing a new optimum that can greatly reduce the environmental impact.

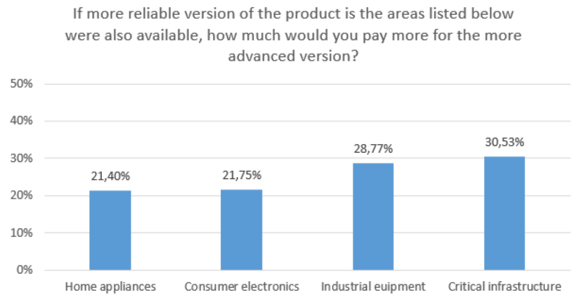

Figure 3. Willingness to bear the extra cost of more reliable electronic equipment

It will be appreciated that further scaling of different manufacturers, different product families, different products, different versions and vintages is not necessarily a viable path in terms of reliability (including manufacturer software, possibly licensed options). It is an option to give the end user the ability to fine-tune the product.

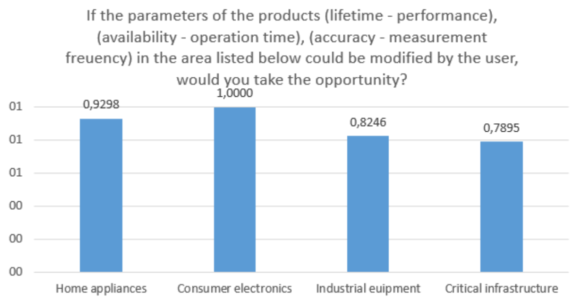

Figure 4. Users' demand for scalable electronic equipment

Figures 4 and 5 show that this would be in high demand by users (yes or no answer for those who completed the questionnaire), especially in civilian areas. Due to their quantity, the consumption of raw materials and environmental impact of civil electronic equipment is much higher than that of industrial equipment.

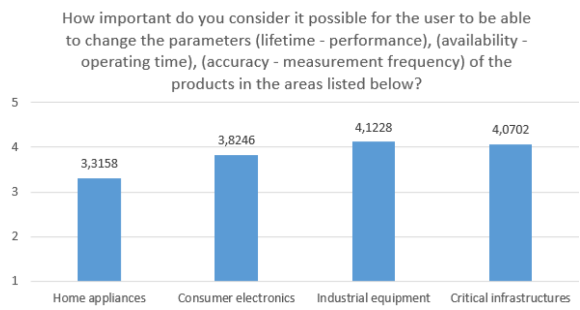

Figure 5. User scalable electronic devices

In the case of civil electronic equipment, the issue of lifetime (in terms of the use of raw materials and resources and the generation of hazardous waste) is also important.

In the case of industrial electronic equipment, performance (in terms of operational reliability), downtime, service time and other reliability parameters are the main indicators of performance.

For island-powered equipment, the user can decide on the balance between availability, uptime, and performance. The power consumption (wake time, calculation time and power) as well as the accuracy and frequency of the measurements also offer adjustment options. Software / firmwares can be used to automate - according to user settings - energy consumption, reduce the frequency of measurements (reducing wake time) and the accuracy of measurements (reducing measurement and calculation time) if the measured value does not change or only changes very slowly. If the rate of change of the measured parameter increases, the measurement frequency and measurement accuracy also follow it. Figure 6 shows that solvent demand would also incur an additional cost of ~ 20-30% to have the option.

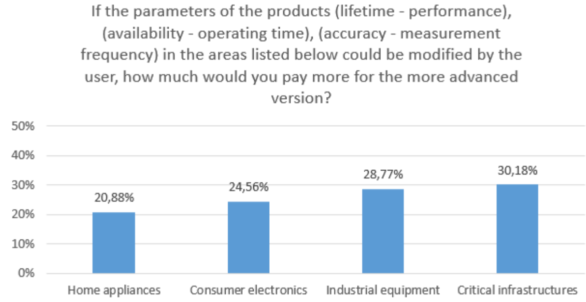

Figure 6. Willingness to bear the extra cost of user-scalable electronic equipment

V. MODULAR STRUCTURE

The ever-expanding reservoir and declining service life of our technical tools used in everyday life means more and more waste generation and resource use. The expanding technical knowledge of users and their willingness to intervene in technical equipment is increasing. With the help of the Internet, the information needed for repair is also widely and easily accessible.

It is important that only users with the right technical training modify electrical equipment, and it is important to increase the number of users with the right technical training. It is recommended to make the acquisition of basic technical knowledge an important part of general secondary education, with the aim of enabling end-users to prevent or eliminate everyday technical problems on their own.

Modular electronic equipment can be repaired in the event of a breakdown with even less resource usage and waste generation at the cost of some extra volume, hardware, software and engineering.

The following example is a model of an island-powered modular power supply system. Figure 7 shows a block diagram of the model. The modules can be easily fixed with screws or flexible lugs, and the releasable galvanic connection between them can be established with ribbon cables. With board-to-board connectors, the modules can be fastened together, and the electrical connection can be done with one device.

The photovoltaic module provides the power supply for island operation. For optimal efficiency, the battery charging module provides impedance matching for the solar panel. The purpose of the battery charging module is to properly charge and discharge the battery, to overcharge, to deep discharge, to charge current, to load current, and so on. supervision. Power and battery charging can also be supplied from an external power source. The DC / DC converter module provides the stable DC voltage required for the load.

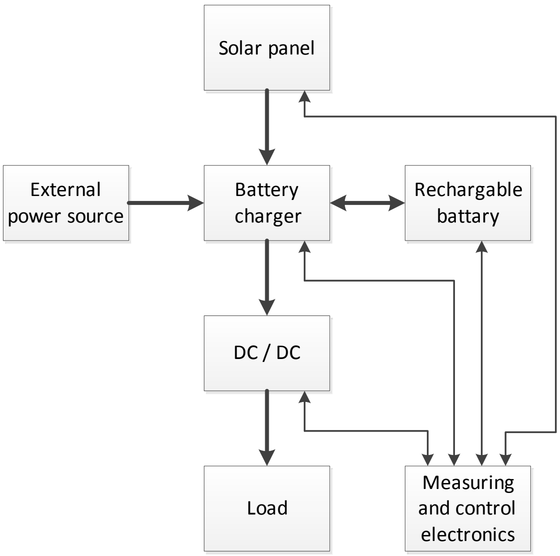

Figure 7. Block diagram of a modular off-grid power supply

The measuring and control electronics monitor the operating modes of each module and monitor their status and store the measured values. The modules can be measured easily with a voltage and current measuring circuit placed in front of and behind them, with minimal component costs. From the measured data, the input and output power for the module can be calculated, and from these, an efficiency for the module can be determined. The modules age and wear out over time. The deterioration of the effects and its speed can be determined from the stored data, and the failure can be predicted for the user with a simple algorithm - with a good approximation. "Appropriate / in need of replacement / inoperative" type feedback is sufficient for the user.

The measuring and control electronics are in practice a microcontroller and hybrid elements built around it, in practice a few euro cents can be realized. Most products have a microcontroller, the firmware / BIOS expansion of the device control and the addition of passive electronics are enough to achieve the new functions.

The control or regulation tasks of the control module could be easily changed by the user within the allowable limits. The user can connect to the device wirelessly or use the submenu of the pre-designed interface on the device.

The device may allow the user to adjust the power-life balance, for example, on a 5-position scale. In the case of a battery (such as a powerbank), in practice, this means that if the user chooses power, it can mean higher charging current (faster charging), changed charging diagram, higher charging voltage, lower deep discharge voltage, higher maximum load current. As a result, a larger amount of charge will be stored in the battery and the electrochemical batteries will also be subjected to a higher load. The price of higher performance, reduced battery life. If the balance tilts towards service life, settings in the opposite direction to the above will be entered into the control system.

In the case of electronic energy converters (eg battery charging electronics, DC / DC converter, etc.), common points of failure are power semiconductor switching elements, high frequency loaded diodes, inductors, filter capacitors. The higher load current means a higher load on said components. The channel resistance (saturation) of MOSFETs increases, resulting in greater heat dissipation, which accelerates component aging. Electrolytic capacitors also dry out under the influence of heat, their internal equivalent resistance increases. These effects lead to a decrease in the efficiency of the module and an increase in energy consumption.

It is also possible to weight the power-efficiency-life values in the case of electric motor control. The operating current for a given speed can be maximized, and the current peaks that occur when the starting current or speed changes, can be reduced by reducing the rate of change of speed or the maximum value of pulsed currents that can be absorbed by the motor. As a result, the mechanical and thermal load and energy consumption of the electric motor are reduced. In the case of a commutator motor, the service life of the commutator and the carbon brushes can be extended (for example, in the case of universal motors also found in a washer or dryer). The motor control electronics also include semiconductor switches, the service life of which can be extended under lower loads.

When controlling heating elements, we can follow a similar line of reasoning. When the heaters are turned on, soft start can be greatly extended by software-controlled or hardware-implemented softstart.

[12 - 25]

VI. CENTRALIZED CONTROL OF ELECTRICITY CONSUMPTION

The ~ 30% of the world's total electricity consumption is for households, ~ 25% for commercial and public services, and ~ 40% for industrial operators. Reducing the cost of renewable energy and developing digital technologies open up enormous opportunities while creating new energy security dilemmas. Electricity from wind and solar energy will provide more than half of the additional electricity generation by 2040 in the established energy policy scenario and an almost complete increase in the sustainable development scenario.

Policy makers and regulators need to move fast to keep pace with the pace of technological change and the growing need for flexible operation of energy systems. Issues such as storage market planning, the interface between electric vehicles and the grid, and data protection can all expose consumers to new risks.

The task is further complicated by the uneven use of electricity within the 24-hour interval.

The power consumption and dynamics of end-user equipment could be modified by the electricity supplier, if justified. [8], [9] The use of a wireless IoT technology may be a good choice for the communication channel. [10], [11] The cost of equipment for the storage of electricity produced from the planned high share of renewable energy sources could be reduced by this solution. The extra cost of hardware and engineering for the product required could be many times higher, resulting in significant resources emerging globally.

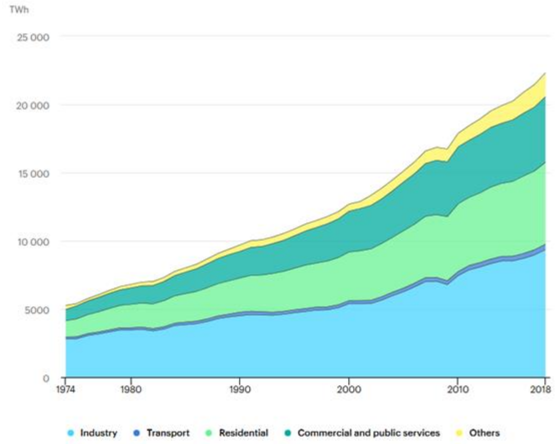

Figure 8. World electricity consumption by sector, 1974–2018 [6]

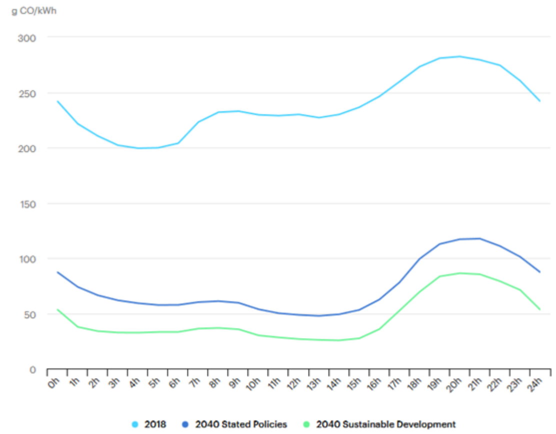

Figure 9. Intensity of average CO2 emissions from 24-hour electricity supply in the European Un-ion, 2018-2040 [7]

CONCLUSION

The authors consider the most important result of this study to be that, based on the presented research, the generation of technical education, which will soon leave technical education and is expected to work for about 45 active years, is definitely important and requires a reasonable surcharge, for the possibility of adjusting the performance-efficiency-lifetime ratios by the end user.

The authors are convinced that the addition of the outlined system component has a relevant market, economic and environmental impact.

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