RATIONAL ENERGY ACCUMULATION AS A CONDITION *SINE QUA NON* FOR TRANSITION TO SUSTAINABILITY

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In order to ensure optimal solutions for all-embracing energy issues, we elaborated scientifically based (mainly on Thermodynamics) *Strategy of Sustainable Energy Development* (*3D-Strategy*), founded on three principles: *Decentralization, Diversification and Decarbonization*. Our credo is - only complex, integrated approach can ensure optimal, sustainable solutions for all energy related problems. It is because the *Universal law of energy conservation* integrates all nature phenomena.

The only possibility for Sustainable Energy Development realization is the *reasonable* use of renewables - as non-carbon, sustainable technologies. The adjective "*reasonable*" is a key word - because in many cases abundantly *subventioned* renewables finally do not contribute to the respective essential gain of free energy ΔG (we prove that ΔG is the universal integral parameter which finally characterizes the result of innovations' implementation). Because of the important shortage of renewables - intermittency - accumulation of energy (and quite often - also its transportation) become critical issues.

Thus, accumulation is an indispensable component of energy-efficient systems. It refers to accumulation of both - high-potential, and low-potential, or thermal energy (secondary energy, or "waste" heat). Intermittence of renewables (especially, of solar radiation), necessity of daily and seasonal temperature variations' utilization - these are additional arguments for the development of advanced accumulation.

High-potential energy storage issue is of great importance especially for *transport*, where specific energy, or *energy density* (measured in *Watts-hours per kilogram – W·h/kg*) - is a *critical parameter*. We prove that, in spite of the anticipated certain growth of electric energy density accumulated in supercapacitors and lithium-ion batteries, "thermal" chemical accumulation will remain the most efficient method of high-potential energy storage. In our opinion, liquid natural gas (LNG) should gradually become the main fuel for transportation - instead of petrol products. Eventually, natural gas could be transformed into completely non-carbon fuel ("safe hydrogen"), and this could be realized in two ways: by means of "on-board" decomposition of methane (CH_4) followed by carbon utilization, or by (cryogenic) capture after burning (combination of different methods also is possible).

From the large amount nomenclature of relatively low temperature thermoaccumulators we especially highlight two - most important - types of thermoaccumulators: related to accumulation of natural ("winter") cold, and the secondary energy ("waste heat") accumulation, coming from the thermal machines (heat engines). Both mentioned types of thermoaccumulators have extremely large potential field of application and - respectively - can drastically change (improve) energy problems solving. For both cases we propose efficient principles and constructions for thermoaccumulation.

Intelligent application of the advanced low temperature (cold) accumulators permits realization of the competitive advantages for the relatively high latitudes' countries - with continental climate. These advantages derive from Thermodynamics (apropos, nowadays - mainly because of the adequate thermoaccumulation technologies absence - seasonal cold and heat are usually irrationally treated as important disadvantages, which finally cause immense damages to economy). We developed non-traditional thermal machine, based on the frozen water (ice) expansion. Unique property of the frozen water to expand by approximately 9% - ensures obtaining of the additional high-potential energy during freezing process, the quantity of which is a strong function of the operating pressure. Large-scale application of the low-temperature thermoaccumulation can decisively improve the economy indices for all the related technologies - air-conditioning, freeze- and vacuum drying, cryoconcentration, cold (refrigeration) storage, etc.

The original solution of the "active wall" is applied for the efficient on-board utilization (accumulation) of the "waste heat" coming from the transport's heat engines. Rational utilization of this - relatively low-potential - thermal energy of a really huge quantities can change entire energy issue, and first of all - the pressing district heating task.

It is worth to mention different adsorbents and absorbents (silica-gel, $CaCl_2$, LiCl, LiBr, etc.) - as non-traditional, open-cycle accumulative heat generators. Such accumulative heat generators also can be treated as no-movable parts accumulative open-cycle heat pumps.

For seasonal thermoaccumulation we develop complex technology which uses chemically-based calcium oxide (“solar CaO”) as a thermoaccumulator (especially favorable for the Republic of Moldova, but not only). “Solar tower” system is the best for obtaining “solar calcium oxide” - the working space of the receiver with the limestone can be heated (due to the advanced concentrated solar system) - to the necessary 800–1000°C. Carbon dioxide emissions (the result of the limestone calcium carbonate - $CaCO_3$ - thermolysis) - can be efficiently utilized in greenhouses, etc.