OPTIMIZATION OF FREE ENERGY GAIN PROCEDURES - FUNDAMENTAL GOAL FOR ENSURING SUSTAINABLE DEVELOPMENT

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There is little consensus over the definition of life, and, consequently, development and its optimization. We consider that the fundamental distinction of living beings (organisms) - in contrast to lifeless (inanimate) nature - is the function of accumulation and use of the free energy (Gibbs's energy G) from the environment, with the subsequent rejection of the "waste" (low-potential, degraded) energy in the environment. Societal progress (development) can be measured exactly - it is direct proportional to the total accumulated free energy. We prove that human society development differs qualitatively from the development of the other species - it can be consciously dirigible, entirely intensive and sustainable. Scientifically based development can be optimized.

Thermodynamic analysis demonstrates that the main goal of all the organisms (life forms) during the life - is the accumulation and use of the free energy.
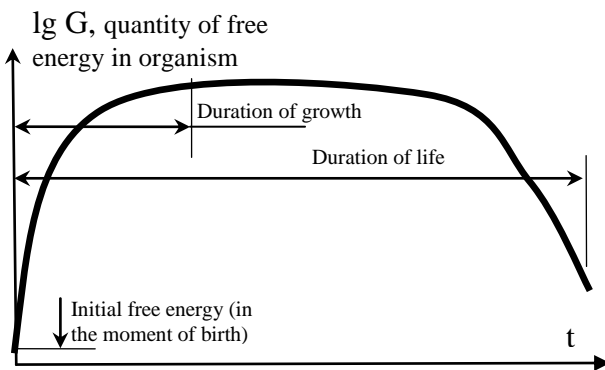

Fig. 1. Evolution of the free energy quantity in the organism vs. time

All organisms (living beings, creatures) need permanent supply (inflow, feeding) of free energy - in order to maintain dynamic equilibrium with the environment:

$$\Delta G = \Delta H - T \Delta S \qquad (\Delta G > 0) \quad (1)$$

Respectively, all living beings (plants, animals) possess the capacity of accumulation of the free energy from the environment in the organism, but - only human beings have the privilege of deliberated, conscious extraction of free energy from the environment and of accumulation of free energy – inclusively, in the environment (no other organisms possess such functions - given "artificial" extraction and accumulation of free energy from (and - in) the environment is due to the human beings' *abstract thinking* capability). We call the first term in the right part of the equation (1) - the variation of enthalpy ΔH - "*extensive*" term, and the second - "*intensive*" one (it depends on the variation of the entropy ΔS).

The total - available for the society - free energy (the sum of accumulated free energy by human organisms, inclusively in the environment) - characterizes the level (degree) of the development. Permanent growth of the total quantity of free energy accumulated by the civilization - is an imperative, obligatory condition for the development (even insufficient (slowing) growth of the total free energy - would mean degradation of the civilization).

Also - because of the forthcoming exhaustion of the crucial natural resources and eventual determinative climate changes - development should be transformed into sustainable one - without disturbance (disruption) of the integrity and stability of the natural systems. We sustain that the gain of free energy ΔG is a universal integral parameter which finally characterizes the result of any activity, inclusively can
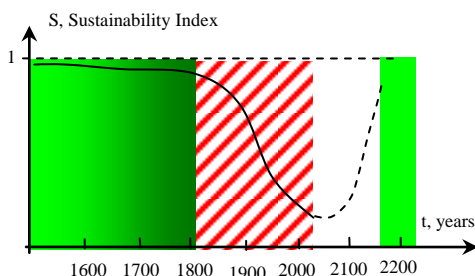

Fig. 2. **Sustainability Index** $S = \Delta G_{renewable} / \Delta G_{fossil} + \Delta G_{renewable}$ *is proposed for the numerical appreciation of the development. The graph represents calculated trend for the Sustainability Index S (dash-line shows the desirable, but yet not ensured trend to "green" sustainability). It is evident that nowadays civilization continues to fall into the abyss of unsustainability (hatched).*

serve as a numerical criterion of sustainability (we introduce *Sustainability Index* for the sustainability grade characterization).

The reserves of extensive development (due to resources and territory extension, population growth, etc.) - expire. It means that the only possibility of ensuring total free energy growth is the intensive development - due to the

second term of the equation (1), namely the reduction of the entropy S (such a reduction is possible globally, and for each organism - because we deal with the open thermodynamic systems and, respectively, permanent energy input from exterior). Reduction of entropy S means progress of research (sciences) and innovations. We propose optimal solutions for the triple challenging task of the sustainable development - *Education - Research - Innovations*.