SmartWatt Weekly

***Episode 10* – The Equilibrium After: Flexibility in Power**

"In the face of uncertainty flexibility is key".

The last article ended with the notion of harnessing the new professional equilibrium, that the universe seems determined for us to adapt to, in order to "inherit fully the capabilities around us and break self-inflicted ties preventing us from soaring the skies of efficiency and resilience".

Resilience which is generally defined as the flexibility to recover following a difficulty, dictates a system or a society's capability to adjust to events, certain or not. This uncertainty in events, took over a two-tier meaning in the current milestone the human race is collectively facing. Uncertainty in the event occurring, where even the most advanced forecasting methodologies could not have even fantasized such a global crippling milestone. And then there is the darkness entrenched in the uncertainty during the event once it happened. The uncertainty where predictions of the outcomes of this milestone, even in the short-term, is far from being an easy undertaking. It is in such uncertain times, that flexibility is no longer a luxury or a strategic priority, it elevates itself quickly and surely into a necessity to maintain some sort of normalcy in our lives as a human race.

True Innovation in the Mechanics of Thinking

For us as a society to transmute flexibility from an approach to an axiom in the root of our functionality as a whole, innovation is key. But the innovation needed is one that becomes situated in the mechanics of our perception and creates new forms of science through dissecting conventional classifications. It is the innovative approach to thinking that instituted disciplines and did so to attain new heights of human advancement. To erupt such form of innovation, the established orthodox needs to be ruptured and a novel framework needs to be inaugurated as the new norm of thinking. This framework has to have the following three elements:

1) Precision – Artistic tendencies in all forms should inspire creativity but development and growth of material produced should be founded fully on precise science. We can no longer afford to base our work on synonym - based approach where two words mean the same; precision decrees that every scrap of a word means one thing and one thing only;

2) Eliminating Benchmarking – Comparison as a philosophy should be abolished from the part of our brains dedicated to creation of material. Models should be developed, bottom-up, with their core tailored to our characteristics and not based on existing norms & practices;

3) Asking the Right Questions – The questions overwhelming our minds should be biased towards what elements will make an idea work and not how it will fail. Assertiveness should

overtake hesitation in our outlook; we should not be asking shall we do this or not, but how to do it in a way beneficial to our societies and to our individual and national requirements.

The Power Sector

Operating a power grid is fundamentally an optimization problem. An objective function is minimized across decision variables to meet parameters that dictate the constraints of this problem. The key parameter has always been the hourly power demand which in classical power grids, was the principal that the entire grid has to follow. This "load following" has to happen instantaneously, to ensure demand is always met by sufficient supply of power at the generation side.

Resilience in the power grid is its ability to ensure reliable supply of power to meet the rigid but fluctuating demand, given the occurrence of disruptions on the grid. Meeting demand reliably means the capability to handle perturbations and contingencies, that may take place, with enough reserve or flexibility in the decision variables of the overall optimization problem to take back the state of the grid to its technical equilibrium.

Those decision variables have been classically the wealth of setpoints on the grid's generation and transmission side that are constrained by physical limitations such as ramp us speeds of power plants, capacity limitations and flow limits, to name a select few. The predominant parameter with foremost importance and overarching reach on the optimization problem governing the operation of the grid was the power demand. The ability to forecast this demand with accuracy while accounting for enough continuous reserve to address the contingencies of events that may happen, chiefly dictated the reliability and resilience of a grid and the cost of attaining such national targets.

Flexibility in the Power Grid

The faithfully original Francisco D. Galiana, my mentor and PhD supervisor, coined, in the early years of this century, alongside F. Bouffard and J. M Arroyo, the term Price of Security. They analytically computed this marginal cost of needed reserve or flexibility from the generation side of the grid to ensure gird resilience. The higher the uncertainty, eluded to earlier, the higher is this cost.

What is required now, given the new outlook of uncertainty revealed by our current milestone, is true innovation in how to secure such reserve & provide consistent flexibility at a cheaper overall marginal cost. To do so, aforementioned innovation should be applied across the following:

1) The Concept – There should be a conceptual and paradigm shift in how the demand, which is the accumulated end user consumption, is perceived from the grid operator. It should no longer be a stress point on the grid, or a rigid parameter that needs to dictate the state of the grid's controllable variables but should be viewed as a decision variable itself that is flexible. The concept of viewing end users as flexible in terms of their power consumption is the foundation of all demand side management and end user engagement practices.

2) The Tools – Innovation needs to transpire how to produce such flexibility from the end users and how to optimize it to meet the grid needs; thus attaining a new cheaper but resilient technical equilibrium on the grid. This is the essence of the professional equilibrium discussed in the previous article. The advanced digitization, energy intelligence and management on remote sites, in addition to holistic viewpoint analytics, need to flourish and be directed to making the end user a flexible load system.

3) The Scope – There are three axes defining the scope on which this flexibility on end-users need to be deployed: i) The first being the depth of resolution of control on a single end-user site. The decision variables now under the control of the grid operator are not the number of flexible sites only; each site is itself a function of control variables governing the power demand on site with minimal effect on the end user. This is analytically driven data intelligence and advanced energy management. ii) The second axis is the width of the number of end user sites being viewed and made flexible. The width should be on a national level targeting sites of different nature: commercial, industrial as well as residential. Iii) The third is the altitude of value to the grid harnessed from such flexible loads. The newfound flexibility should be used to reduce overall marginal generation cost, to provide ancillary services such as regulation, to shave off major generation and infrastructure investments on the grid, and even used to facilitate national level energy efficiency enhancement programs.