Different Energy Basis- Vector Integration for Storage of Energy (DEVISE)
Joint Call 2019 (MICall19)
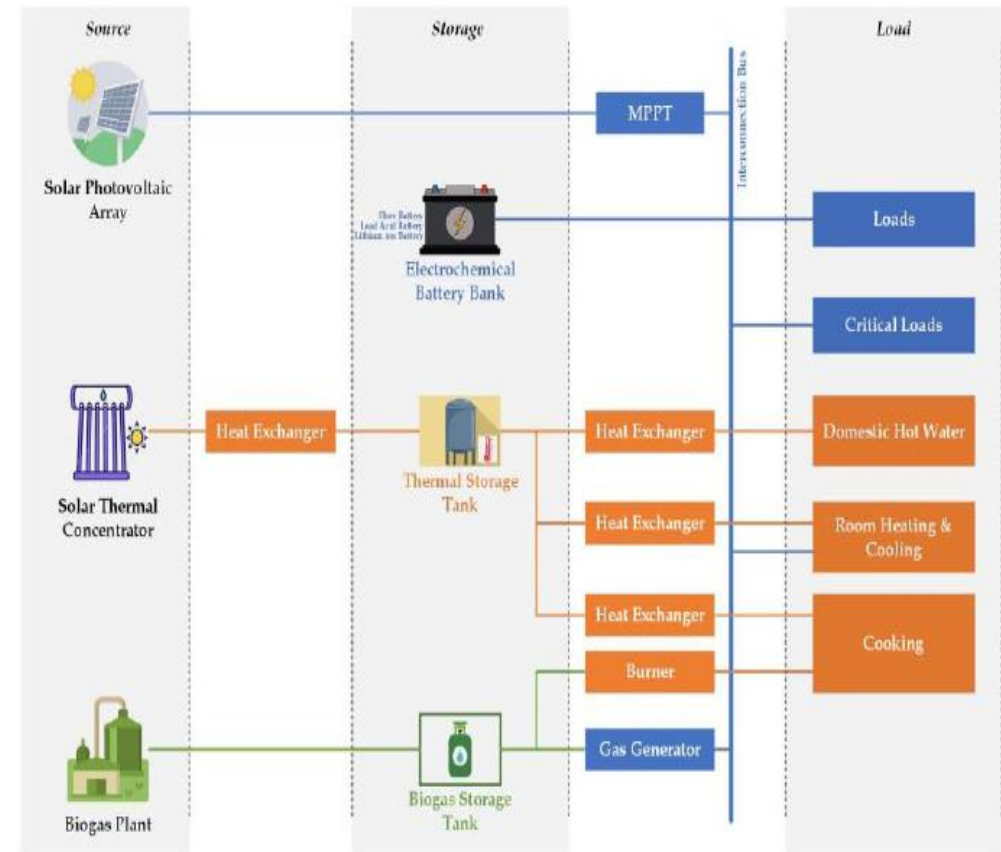
Project Duration
30-12-2020 to 29-12-2023

Partners:

- The existing micro grids integrate various renewable energy sources with the grids. However, such micro grids are heavily biased towards electrical energy. Other forms of renewable energy are converted into electrical energy for integration with the grid.

- At present the storage of energy is also predominantly electrical but this strategy prevents the efficient and rational end-use of diverse sources of energy.

- Therefore, there is a need for development of a more holistic definition and design of renewable energy micro grid, which ensures efficient integration/transformation of different forms of energy for rational end-use and storage of all forms of renewable energy to facilitate the optimal interchange of energy from one form to other.
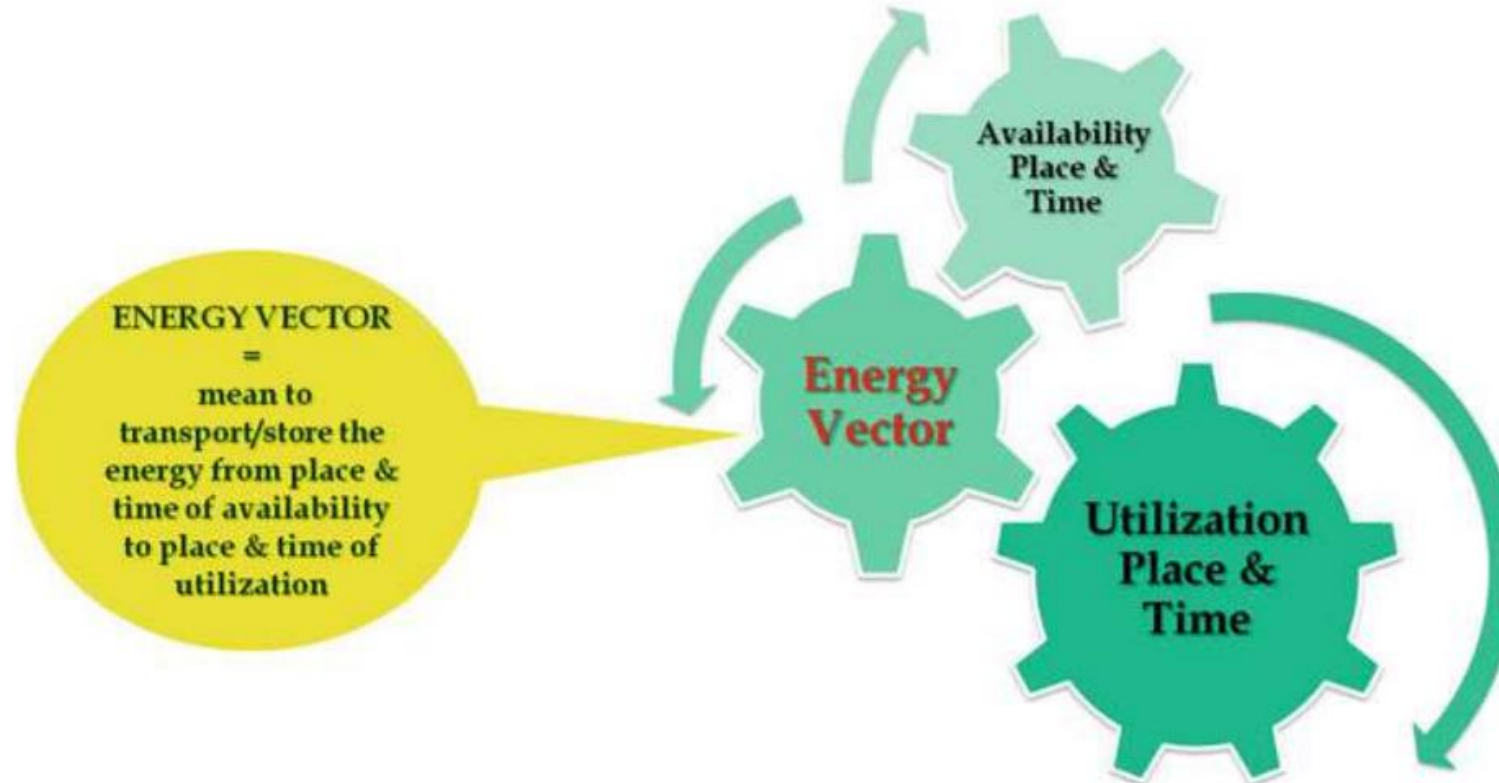
- The **Goal** of DEVISE is to design and implement a hybrid micro grid of electric and thermal energy with heterogeneous storage and relevant energy conversion inter-linkages. Further, to demonstrate the pilot for emphasizing its utility as solution to energy needs in general and particularly in village/rural setup to give necessary impetus to development where even in present modern age the majority of Citizens of Sovereign Republic of India live & work.

- Energy vectors are the energy forms derived from natural resources to enable its transportation, storage and use in another space and time.

Ref: Handbook of Sustainable Engineering, Springer

Storage of following energy vectors are being considered in DEVICE

- Hydrogen

- Electrical energy : Resource - Solar Photovoltaic

- Thermal energy : Resource – Solar Thermal

- Bio-gas : Resource : Dairy Waste

- The vector basis of a vector space V is defined as a subset of $v_1, ..., v_n$ of vectors in V that are linearly independent and span V. Consequently, if ($v_1, v_2, ..., v_n$) is a list of vectors in V, then these vectors form a vector basis if and only if every $v \in V$ can be uniquely written as

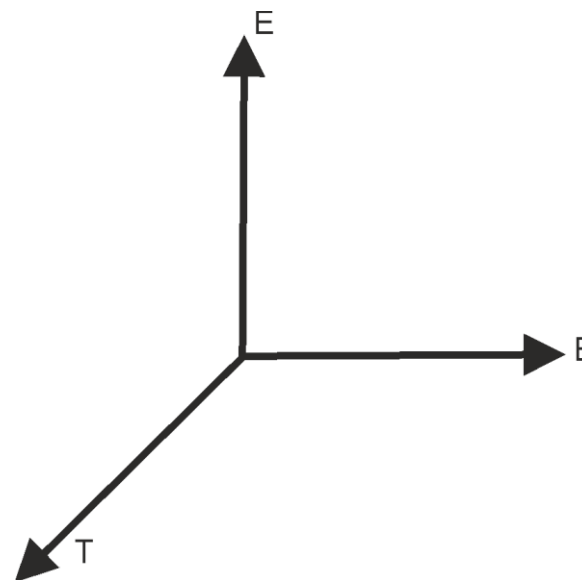$$V = a_1 v_1 + a_2 v_2 + ... + a_n v_n$$

where $a_1, a_2, ... a_n$ are the elements of the base field.

- A Vector space V has many different vector bases, but there are always the same number of basis vectors in each of them. The number of basis vectors in V are called the dimension of V.

- DEVISE comprises of different forms of energy storage i.e. Electric, thermal biogas and Hydrogen as energy storage basis vectors.

Energy Storage Vectors
Electric Storage (E)
Thermal Storage (T)
Biogas (B)
Hydrogen (H)

A linear combination of the basis vectors **E**, **T** and **B** should be able to meet the required energy load (**L**) for a given case study
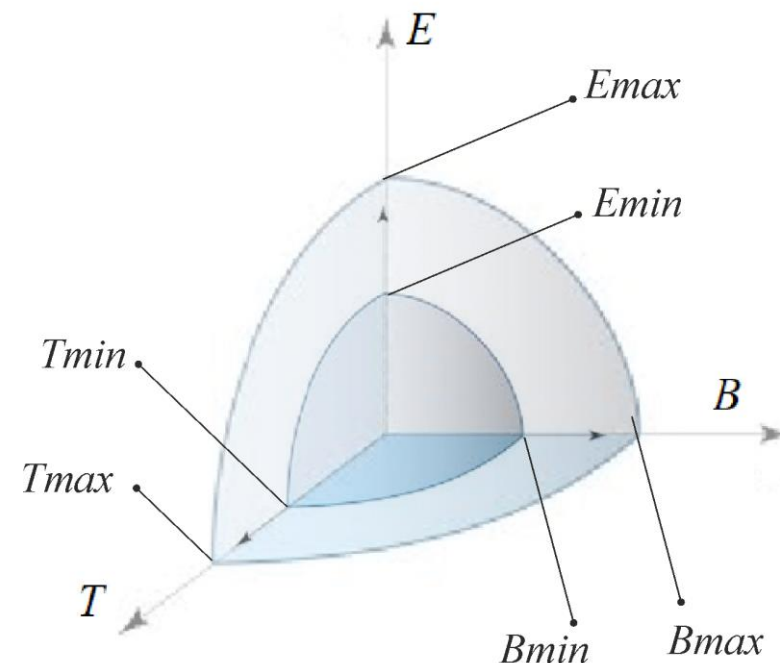
$$L = a_1 E + a_2 T + a_3 B$$

with condition that

$$E_{min} \leq \alpha E \leq E_{max}$$
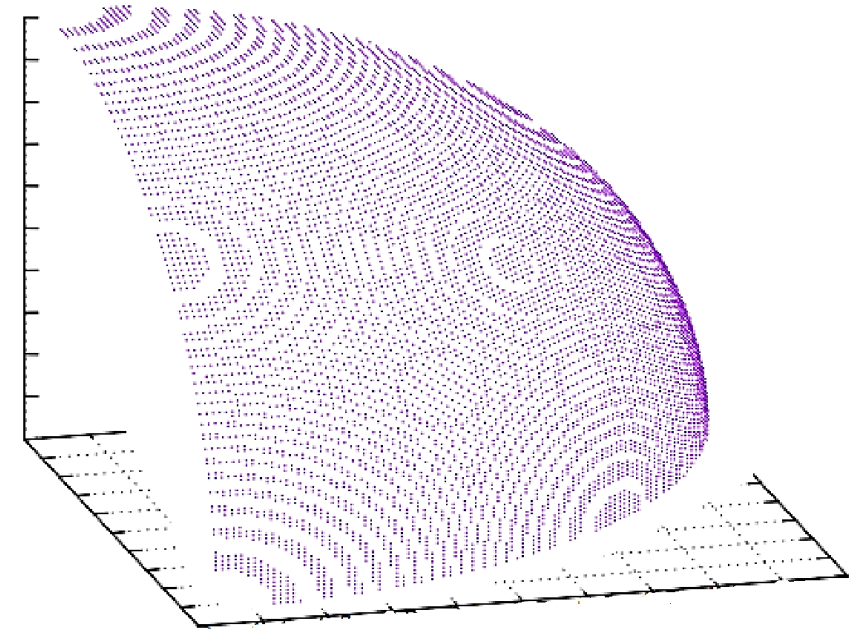
$$T_{min} \leq \beta T \leq T_{max}$$

$$B_{min} \leq \gamma B \leq B_{max}$$

The Idea is to get the optimal values of elements a_1 , a_2 , and a_3 so as to optimize the mix with respect to a number of objectives which may include, but not limited to the following:

- Economy
- Energy Density
- Sustainability
- Efficiency
- Charge/discharge rates of storage
- Energy availability

- **In most problems these objectives are in conflict with each other.**

- So the task of multi-objective optimization is different from that of single-objective optimization

  - there is usually no single solution which is optimum with respect to all objectives

  - The resulting problem usually has a set of optimal solutions, known as Pareto-optimal solutions, non-inferior solutions, or non-dominated solutions

  - **the goals of multi-objective optimization is to find as many Pareto-optimal solutions as possible.**

The solutions included in the Pareto optimal set are called *non-dominated*.

- **Definition 1 (Dominated)**

  A vector u=(u1,…,un) is said to be inferior to v=(v1 ,…, vn) or u is dominated by v iff v is partially less than u (v *p<* u),

- **Definition 2 (Superiority)**

  A vector u=(u1,…,un) is said to be superior to v=(v1 ,…, vn) iff v is inferior to u.

- **Definition 3 (Non-dominated)**

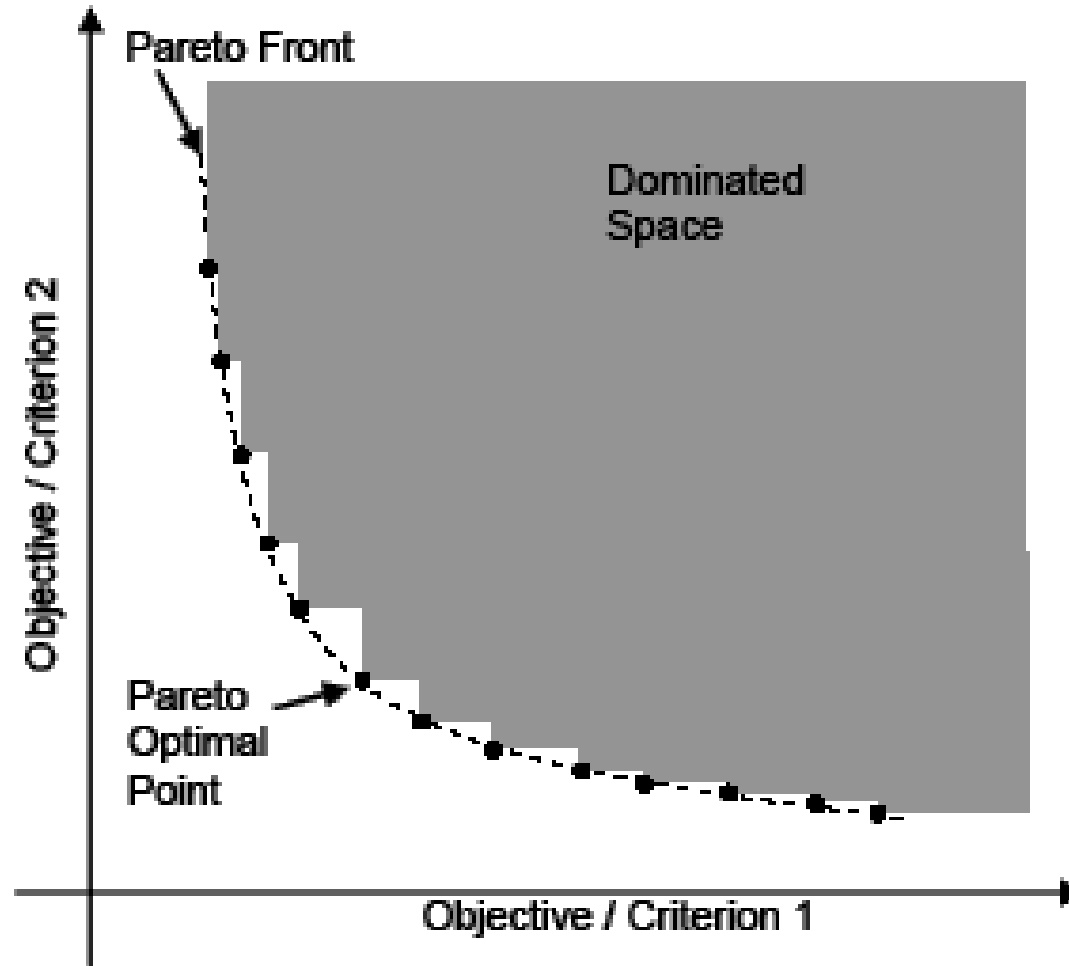 Vectors u=(u1,…,un) and v=(v1 ,…, vn) are said to be non-dominated to one another if v is neither inferior nor superior to u.

Each element in the Pareto-optimal set constitutes a non-dominated solution to the multi-objective problem.

- The plot of the objective functions whose non-dominated vectors are in the Pareto optimal set is called the *Pareto front*.

Typical Pareto optimal front for an MOP with two objectives

PROJECT SITE : DAYALBAGH

- **Dayalbagh**, which translated into English means 'Garden of the Merciful' is a self-contained Eco-village with an organised way of life that conforms to the spiritual ideals of the **Ra-Dha-Sva-Aah-Mi Faith**

- Community living based on the "Dayalbagh Way of Life", "Better Worldliness" and "Simple Living High Thinking"

- Recognised as Charitable Incorporated Organization around the Globe, Dayalbagh represents a sustainable and scalable System of Systems, with a Holistic interplay between several Systems, some of which include:

  - Esoteric System (Consciousness System)
  - Education System
  - Social System
  - Agroecology cum Precision Farming System
  - Renewably Energy System ….. And so on.

- An important emergent attribute due to the interaction of these systems is the attainment of happiness and Blissfulness for all and for ever and ever, which may be characterized colloquially as "**bringing a cutie-pie smile to all faces**" in the present time, as against the enigmatic smile of Monalisa, famously created by the genius and universal talent Leonardo Da Vinci, embodying the spirit of his time in the 15th Century.

GRACIOUS COMMENT

The aforementioned attribute of Dayalbagh is possible only through the Gracious Vision, Initiative, Guidance and Encouragement of our **Revered Chairman, Advisory Committee on Education, Prof. Prem Saran Satsangi Sahab**. I would like to quote His Gracious Comment for this occasion:

" Ultra-transcendental Contemplation/Meditational Practices (vide Power Law of Ultra-transcendental Meditational Practices of Consciousness primarily catering to the deprived sections of the society, referred to as the Last, the Least, the Lowest and the Lost among all living-beings, particularly Gender-free mankind) : while Cloud Computing (referring to Art, Science and Engineering) permits operators like Zoom, Google (both subject to concerned Governmental Regulations) as relevant to functions between inverse frequency between stimulus and sensation at exponential scale as seven energy forms (VIBGYOR) to be used directly as per needs. In case of excess energy, this is stored in Electric Battery Banks and may be used for any of the major five end users; dispensed at Naval Point, Heart Point, Throat Point, and two in the Purely Spiritual/Charitable Domain; often referred to as Charitable End Users, e.g., Healthcare Habitat propounded by WHO & UNESCO, mainly for Artisans and Landless labour for curative and palliative measures including women in combative training."