



Making decentralised storage-economics work to enable rapid growth of Renewables

Ashok jhunjunwala, IIT Madras, India

Advisor, Minister of Power and MNRE, Government of India

ashok@tenet.res.in

Can Renewables become the dominant source of India's Power?

- Cost of Power from solar and wind **already touching** that from greenfield coal-based power plants in India
 - Renewable Costs will **only fall** from hereon
 - India is rich in sun-light
- What stops Solar PV not be the **principle source** of power-generation for India in line with our commitment as part of the Paris Accord?



Intermittent nature of Solar and Wind Power generation is a problem

- Power generated needs to be consumed **instantly or stored?**
 - Grid-storage is three to **four times** the cost of power generation
- As both demand and supply vary independently
 - either get thermal generators to **back off**: will increase the cost of thermal power
 - or carry out **Demand management**, where customer is incentivised to use more power when grid is surplus and less when deficit
 - But demand management **requires storage**: how will we justify costs?



Renewable Compulsion

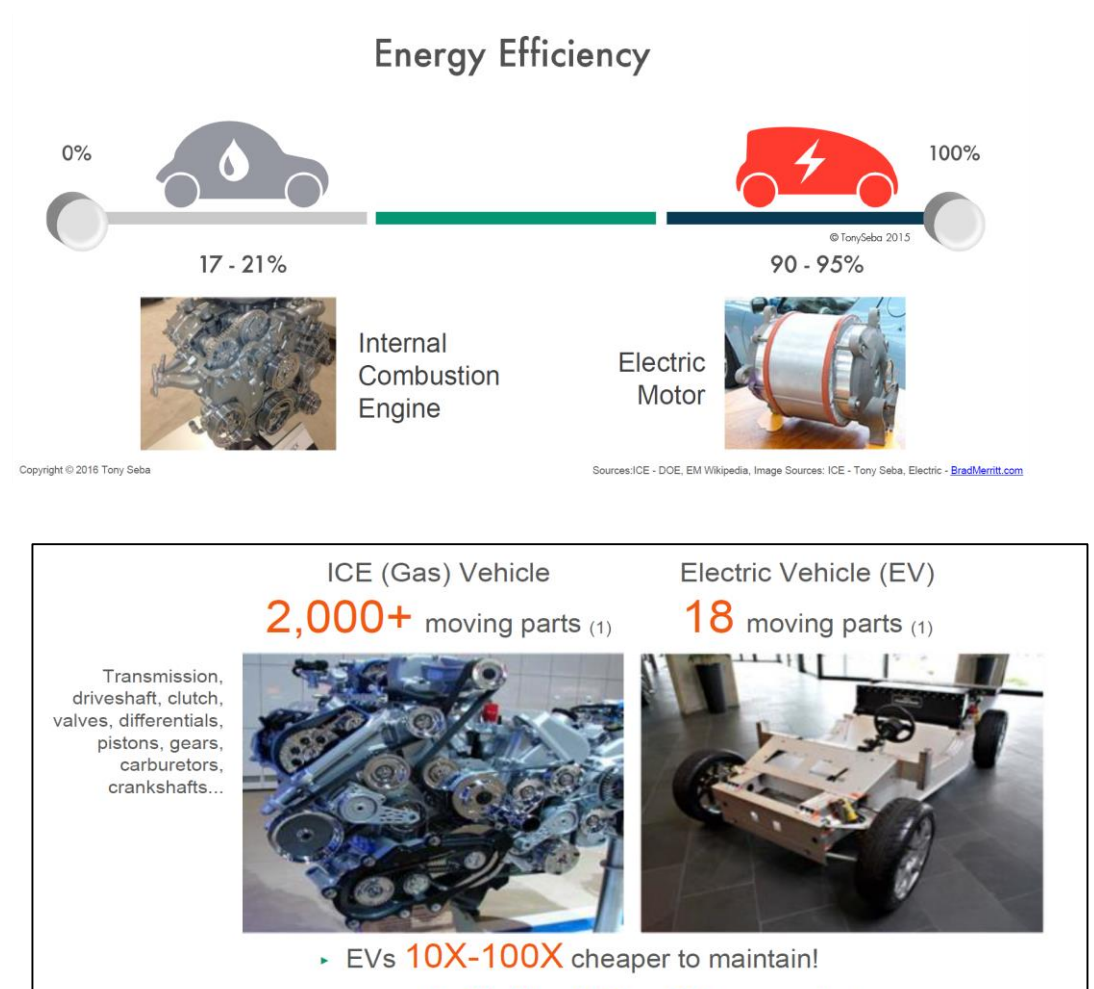
- Renewable power will become an unfettered dominant supplier to power-grid only with some kind of large-scale storage
 - where the related costs are independently affordable in the context of the specific application of the stored energy
- The answers are
 - Electric Vehicles with their storage
 - Roof-top solar-DC homes with storage
 - Smart buildings and factories with storage
 - and implementation of demand management for all these



Electric Vehicle is future transport

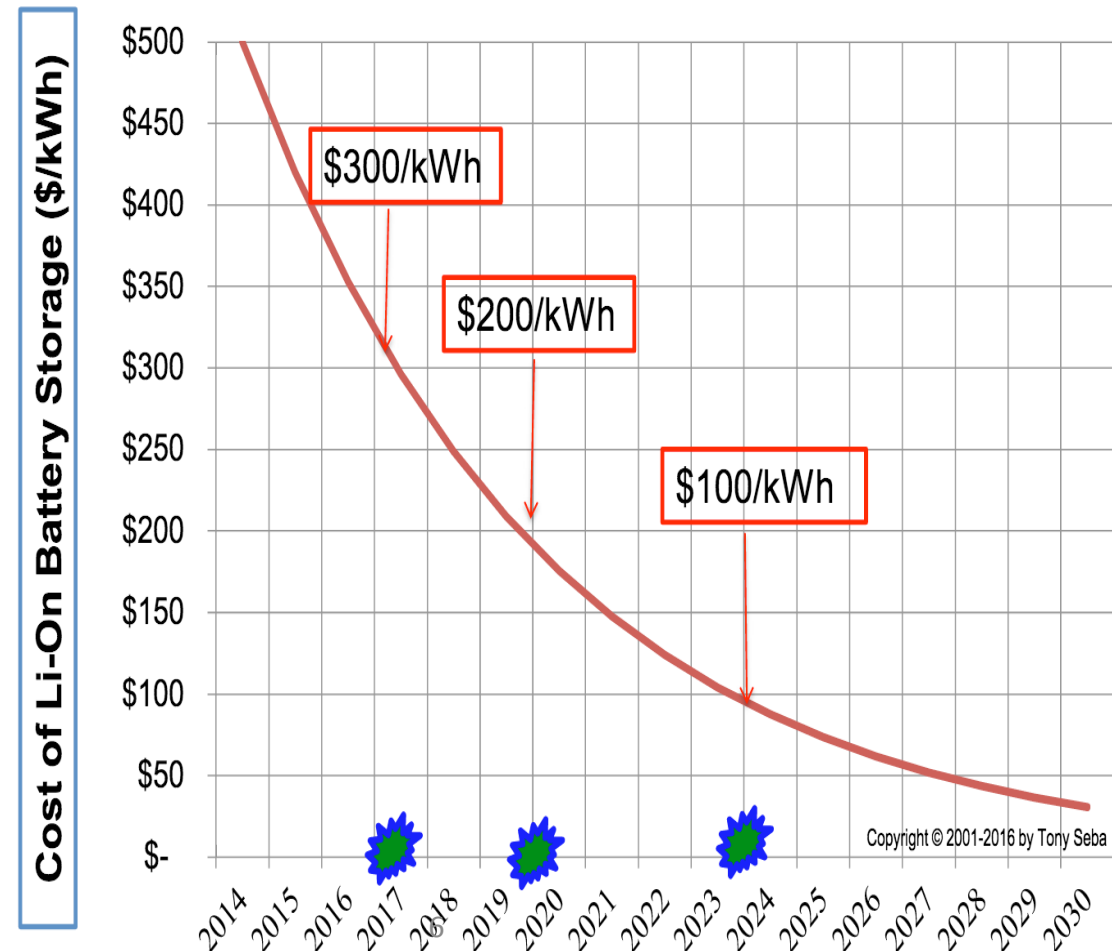
- Electric Motor: **5 times** more energy efficient as compared to Internal Combustion (IC) Engine
- Electric Vehicles are far more **Reliable**
 - Have 100X fewer moving parts

- EV vs Petrol vehicles today
 - Capital costs without battery equal
 - Operational costs equal for 100 kms /day
- EV vs Petrol vehicles in 2020
 - Capital costs with battery equal
 - Operational costs 0.2



With Battery prices falling rapidly

- EV will happen in India too in four to five years
 - But then others will drive it and
 - we will **import EV sub-systems** like we import oil today
- or we can **make EV happen today** by careful effort
 - and take lead in certain segment and manufacture in India
 - **\$130 billion a year** new industry by 2030
 - Motors, controllers, batteries, chargers, dc-dc converters, electric brakes, electric air-conditioning, light weight materials



For EV to happen today

- Drive motor-efficiency to **higher vehicle kms per kW** especially in Indian drive condition to reduce battery size and vehicle costs
 - just like higher *kms per litre for petrol vehicles*
- Reduced Battery-size and vehicle costs
 - By use of **battery swapping** in certain segments
 - and Lowest-costs **Fast Charging** Infrastructure in others
- EVs would provide the *first large-scale storage* that the growth in renewables needs
 - All electric vehicles today would use **15 to 20% of India's electricity generated**
 - Smart charging of EV batteries using demand-response could help overcome the intermittent nature of renewable-power generation



Smart Buildings and factories

- Energy **storages (not just batteries)** in Buildings and factories would provide the second large-scale storage for renewables
 - **Chilled Water Storage**: chill air-conditioning water when grid is Surplus
 - **Cold Air as Storage**: cool the offices a bit more when surplus grid and let offices warm a bit when grid is deficit
 - **UPS Battery as storage**: not just as power back-ups, but participating in demand management
- Cost justified independently in terms of savings of power-bills
- *detailed talk on “Preparing for High-mix of Renewables in India’s Power Generation”*



Solar-DC in every home

IEEE Spectrum Winner of the 2017
Technology in the Service of Society Award

- **DC power-line** at homes
 - Roof-top Solar directly used as DC power provides the **lowest cost electricity**
 - DC-powered DC appliances **40 to 50% more efficient** as compared to AC ones
 - Provides **back-up power** during grid power-cuts / failures / disasters
- Together, storage at homes would provide third large-scale storage for grid
 - Solar-DC should have smart-storage with demand-response



To Sum Up

- *Electric Vehicles, Smart buildings and factories, and Solar-DC* at each home are highly beneficial for the segment they serve
 - important for India and have **independent economic justification** for customers
- But ALSO provide the LARGE Scale Storage that **electric grid needs** to enable renewable growth to an unprecedented level
- Only when we enable these in India **at Indian costs with Indian specifications**, our grid will become SMART
 - Not by copying the WEST

