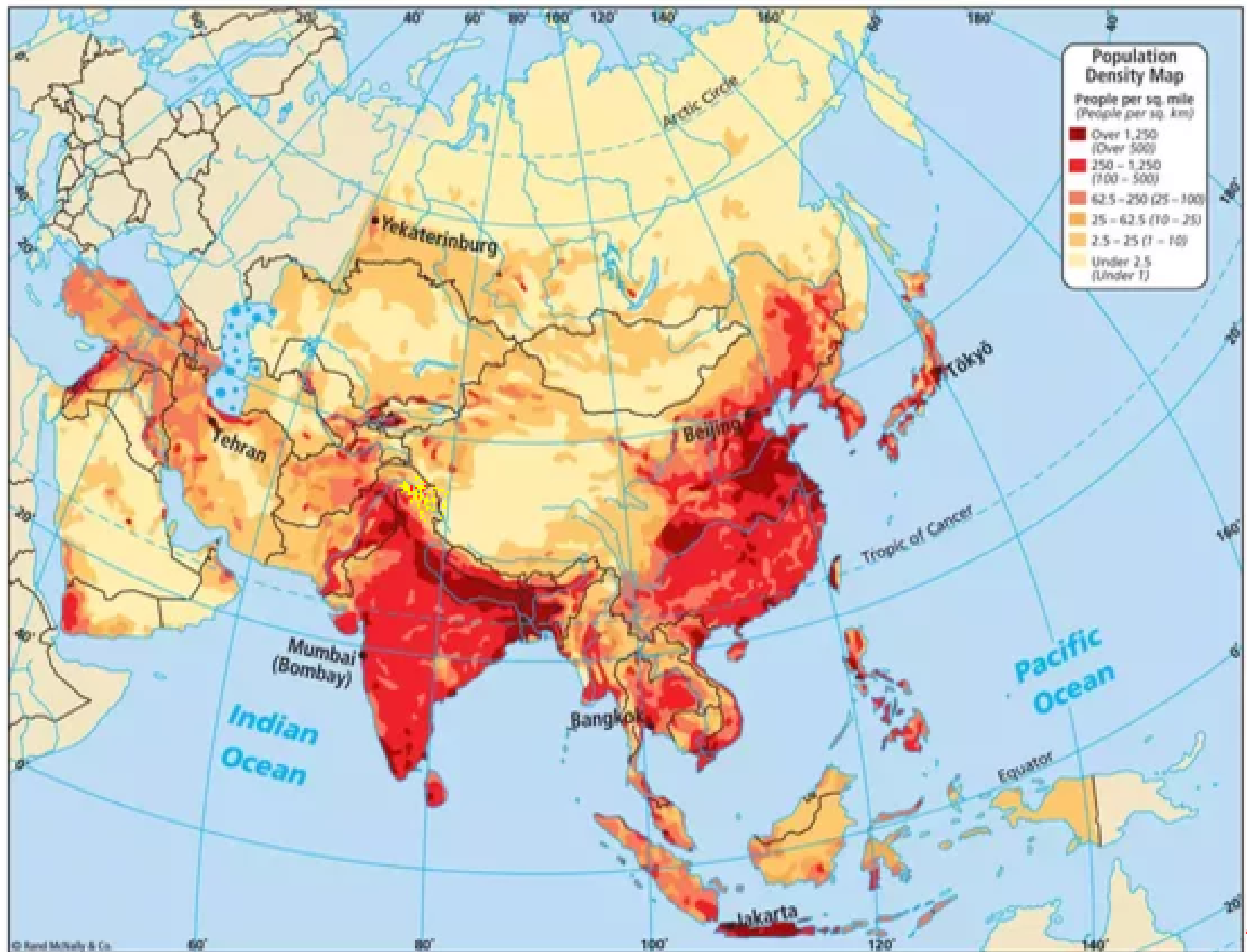


Decarbonise Transport

- Transport sector is a vital enabler of economic activity.
 - ~ Roads carry 85% passenger traffic & 60% freight.
 - ~ \$76 Billion on crude oil import in FY16. Transport Takes 70% of total Diesel consumption and almost entirely (99.6%) of petrol consumption.
 - ~ transport related emissions to increase from 9.4% in 2009 to 16% in 2035. WHO - India has 13 of world's top 25 most-polluted cities,
- UN Framework Convention on Climate Change (UNFCCC),
 - ~ National target is by 2020, the GHG levels go down to 20-25% below 2005 levels – mainly Renewable Energy (RE) target of 175 GW, and Electric Mobility
 - ~ Intense urbanization expected - half the population to move to urban areas in 30 years,
 - ~ Pollutants from IC Engine Vehicles accentuated – heavy concentration in a small urban areas can cause significant air pollution problem.

Population Density



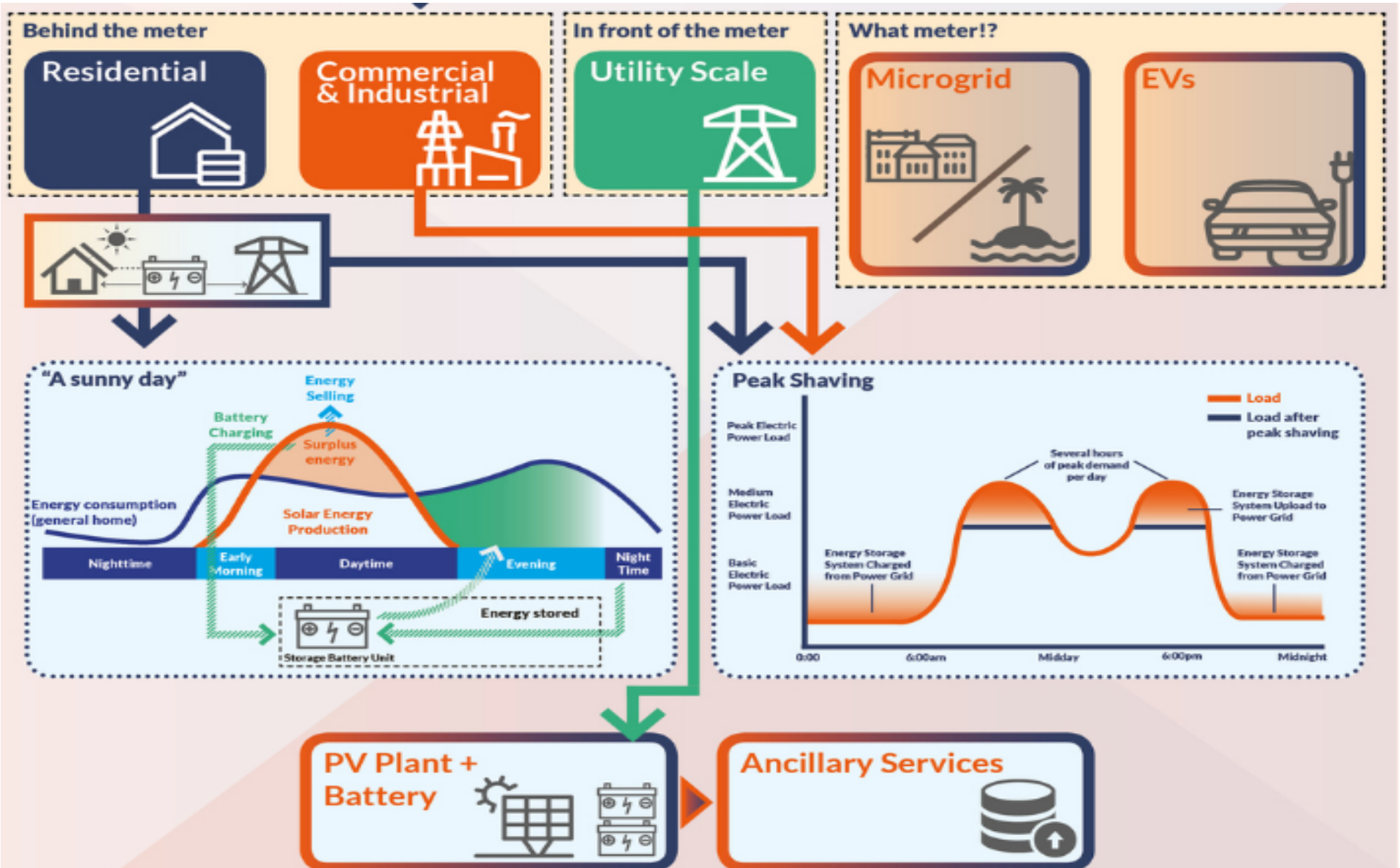
Conversion to Electromobility

- Integrate Electromobility into Smart City Agenda.
 - ~ Bring together a large collection of Bus Service Providers, Taxi Operators and Aggregators, and their associations, along with major transportation research groups, policy study agencies and with the representation from relevant Government Agencies,
- Introduce Sustainability Obligations in Public Procurements
 - ~ Collaboration with Industry & Research, India Smart Grid Forum, Bureau of Indian Standards, Association of Road Transport Undertakings (ASRTU).
- Use IT as enabler for EV Deployment
 - ~ Interoperability of Payments & Real-Time Information on Charging Points.
 - ~ Mobile phone enabled Taxi Aggregation business to enhance the Electric Taxi Fleets
 - ~ Incentivise Consumer behaviour through Tax & other instruments

EV Fleets & Renewable Energy

- Electric Mobility is urban focused
 - ~ to the reduce local pollution in the city areas, and to reduce fuel bill for country.
- Large EV Fleets help to establish charging infrastructure.
 - ~ EV Buses has defined routes, passenger loads & predictable energy usage. An Emerging business opportunity for Electricity Distribution Companies, as it represents a constant and large load.
 - ~ The supply chain for EV Charging Equipment Manufacturing will get established.
 - ~ EV Bus Fleets for IT parks & commercial hubs are a priority, to win to attract a new segment of the population to public transport.
- Long term sustainability
 - ~ Electric Mobility support the renewable energy grid, by providing energy storage as a short term buffer for the fluctuations in renewable energy generation.

EV – Grid Interaction



Electricity Grid Issues

- **Peak Shaving:**
 - ~ Injection of local active power stored in the batteries of EVs during peak load hours can help lowering the peak power demand of the distribution system. Active power regulation can be used for maintaining the frequency of the grid at 50 Hz and to minimize voltage fluctuations.
- **Spinning reserve**
 - ~ Online generators that can change their output instantly in response to major transmission outages to reach their full output within minutes & capable of sustaining for few hours. Is required less frequently than active regulation.
- **Reactive Regulation**
 - ~ Power Quality issues faced by users at the points of supply: voltage variation & interruptions
 - ~ Harmonics, arising out of customer's power utilisation.
 - ~ Power quality issues : including power quality indices in the performance evaluation of Discoms is recommended.

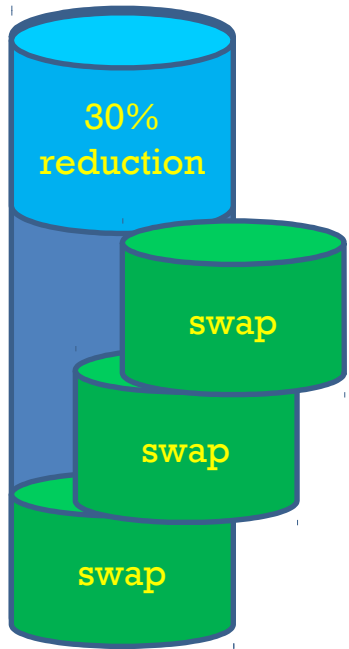
HLG : A focus on EV Buses

- Smaller, lighter and affordable EV Buses
 - ~ Electric buses carry a large upfront CAPEX cost & low OPEX cost.
 - ~ A 9-meter electric bus is better in the Indian scenario as compared to the 12-meter regular bus structure. Navigating congested, narrow city routes, optimize the occupancy levels, and significantly lower upfront CAPEX due to smaller battery required.
- Convert existing diesel buses to electric buses.
 - ~ Provide affordable & clean transportation to the very large population - contribution to the development goals.
 - ~ 1.2 million buses in operation, with 50,000 added every year. Each diesel bus emits 48 tonnes of CO₂ per year on average. Replacing 5000 diesel buses with electric buses reduce diesel consumption by 95 million litres and reduce CO₂ emissions by 2,38,000 tonnes.
 - ~ Fuel costs account for almost ~35% of the overall operating costs for a Transport Undertaking.

EV Deployment Strategy: EV scaling starting 2017

- ~ Battery price dominates EV costs: use innovative techniques to offset high battery prices
- ~ **Intervene in Public transport segment**
 - Private vehicles will follow
- ~ Get Volumes: volumes reduce costs

Challenge and Approach



- Battery (without range anxiety) most expensive component of EV. Focus to be to enhance efficiency (kms/ kWh), especially for 10 to 30 kmph speeds
 - ~ By higher motor efficiency, using better tyres, better aerodynamics and light-weight materials
 - ~ 30% reduction done in many cases
 - ~ Still costs too high
- Introduce Swapping
 - ~ Divide into smaller parts so that each part not as expensive
 - ~ Purchase vehicles without batteries
 - ~ Capital costs has to be equal or less than equivalent ICE vehicle costs
 - ~ But with enhanced efficiency
- Treat battery ownership, swapping, charging as separate business ensuring that operation costs (cost per km) is no more than that for ICE vehicles

In three wheeler domain



- e-rickshaw
- e-auto
- e-auto (large)

Use **swapping**: 50 km range battery

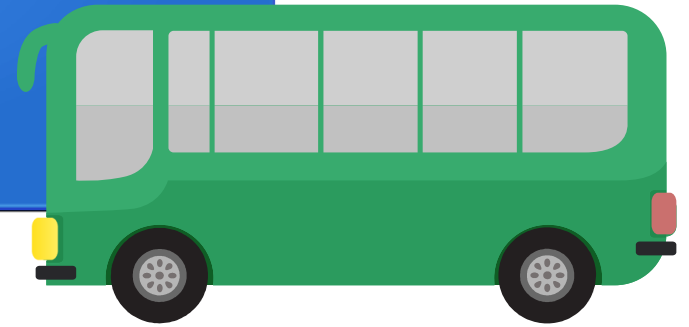
- **Quality** electric vehicles at price level **same as ICE vehicles** today
- Charged Battery **hire price** per kms no more than that for ICE vehicles

Tasks and progress (green done, brown underway)

- **Meet manufacturers, battery manufacturers, potential battery swappers and vehicle aggregators**
- Make specs for swappable battery
- Make specs for quality e-rickshaw and e-auto
 - Higher motor efficiency motor and driver
- Make specs for charger-bank
- Find a company to purchase and lease 200K to 1 million vehicles with five years warranty
 - Lease vehicles to aggregators
- Find a company to do battery business
 - Find locations for charging / swapping
- **Select cities for launch**

Everything other than battery cells made in India

For city-buses



Most city buses travel less than 30 kms per trip

- Some 8 to 10 trips per day
- Ten minutes break between trips

Choose **batteries with 50 kms** range (non air-conditioned)

- **Swap batteries** (using robots) at trip-terminal point
- Ensure that cost per km is no more than for diesel vehicle

Buses will be obtained without battery

- Has to have high performance (**minimal Wh/km**)
- Costs **less** than or equal to today's buses

Tasks and progress

- **Meet manufacturers, battery manufacturers, potential battery swappers**
- **Make specs for swappable battery**
- **Make specs for buses**
- **Make specs for charging / swapping infra**
- **Find a company to purchase buses and provide to STC on full-lease basis**
- **Find a company to do battery business**
 - **Find locations for charging / swapping**
- **Co-opt State Bus corporations and cities**
- **Select cities for launch**

4-wheelers: needs fast chargers

- Focus on **taxis**
 - Typically Runs about 200 kms/day
 - Economics work out
 - Cost per km comparable to that for ICE vehicles
- Have a range of 110 kms
 - Range to be **extended to 160 kms at same costs** by July 2018
- Charges **overnight** on AC plugs
- Need **fast charger**
 - will mostly charge in **one hour**
- Also today's vehicles (sedan) available for Government lease at **same rates** as ICE vehicles.
- Overnight **slow AC charging** at homes
 - two hour AC charging while parked at office can **extend range** to 150 kms
- DC **fast charger** for one to one and half hour charging

Tasks

- **Bharat Charger Specs released**
- **Get Chargers developed**
- **Make Charger business viable**

Focus on cell manufacturing in India in 2019



Thank You