

Decarbonisation of Transport in Sri Lanka

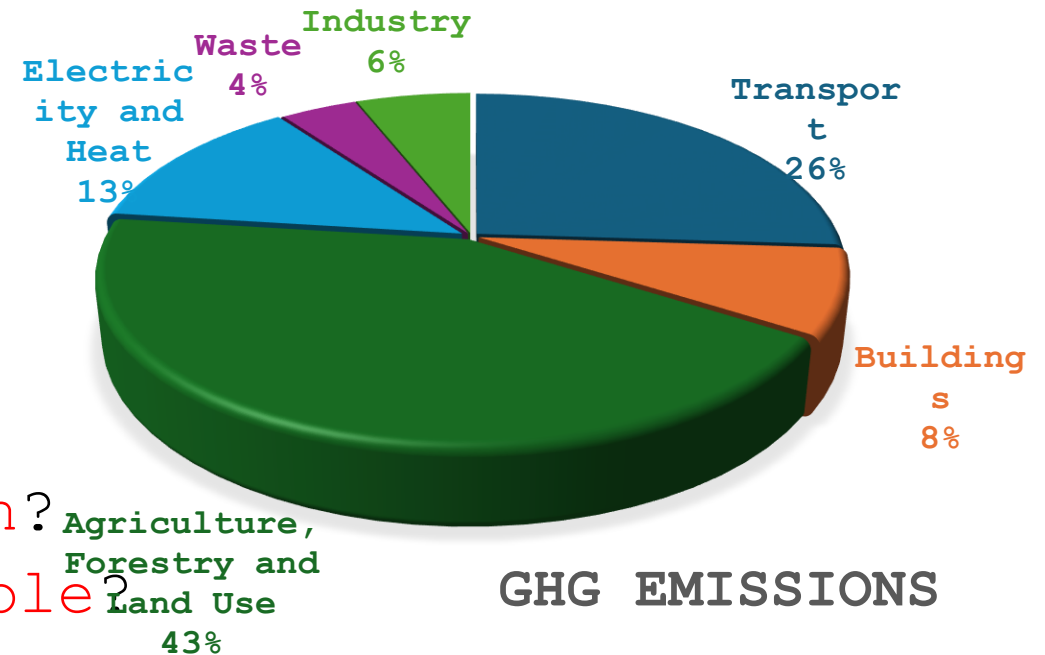
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Why should Sri Lanka to
move
quickly to Electric
Vehicles?

- Sri Lanka consumes 100 TWh of energy per year
 - About a third is for transport: 70% of IMPORTED fuel
 - Contributes significantly to Sri Lankan GHG emissions and air pollution
 - Hurting Sri Lankan economy significantly

- Can Sri Lankan transport be converted to electric?

- Will this cause inconvenience for consumers?
- Will this make transport Green?
- Will this be economically viable?



The nay-sayers

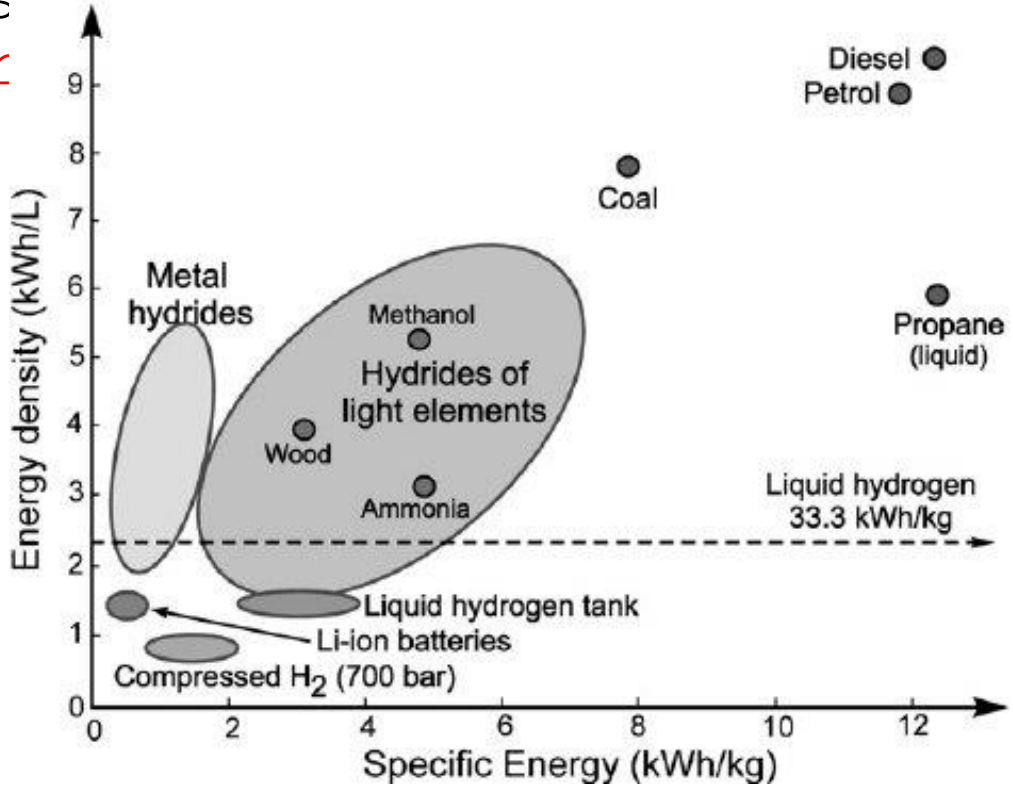
- Donald Trump, EV-basher-in-chief, complained that they “cost too much and don't go far”
- Grid is any-way **dirty**: mostly using coal
 - EVs will be consuming mostly coal-based electricity
- **Charging Infrastructure** do not exist
- Battery and Solar panels will create **huge waste** at the end of life

The nay-sayer

cost too much - don't go far:

True, but ..

- Battery (energy-container) is 8-10 times heavier and larger than petrol fuel-tank
 - Drives up Costs, Size and Weight for Electric Vehicles
 - Newer higher-energy Batteries help
 - not enough
- Smaller batteries with swapping an option
- Hydrogen fuel will reduce size and weight: too far in future



.. but not for long

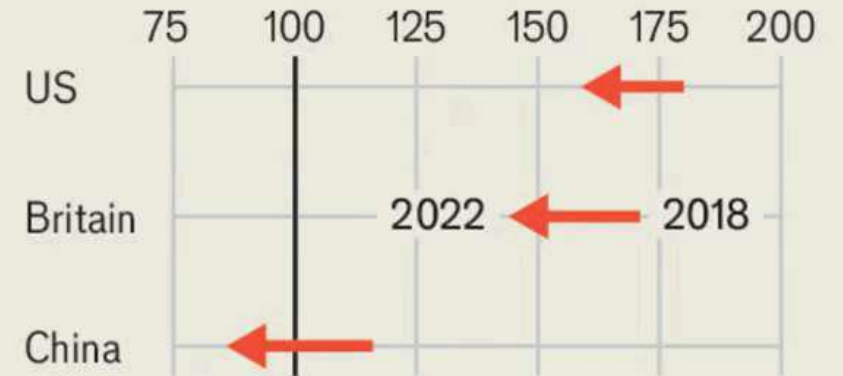
- Purchase **Cost falling** down rapidly
 - Going below that for petrol vehicles
 - Fuel cost far less: **about a tenth**
 - plus lower maintenance cost

• *Don't go far*

- 95% of days, usage is below 100 kms: charge in **three hours** for best battery life
 - Above 250 kms usage may be only **2% to 3% days**: Fast Charge can be carried out **15 to 20 minutes** (battery life impacted only to a small extent)
- For fleet vehicles, use **larger** batteries or batteries which are capable of taking **FAST CHARGE**: both costs more
 - Both costs more, but **higher costs recoverable** by savings in fuel-cost in a year or two

Electric car prices

As % of non-electric cars, pre-subsidies



Source: International Energy Agency

Battery Swapping: another option

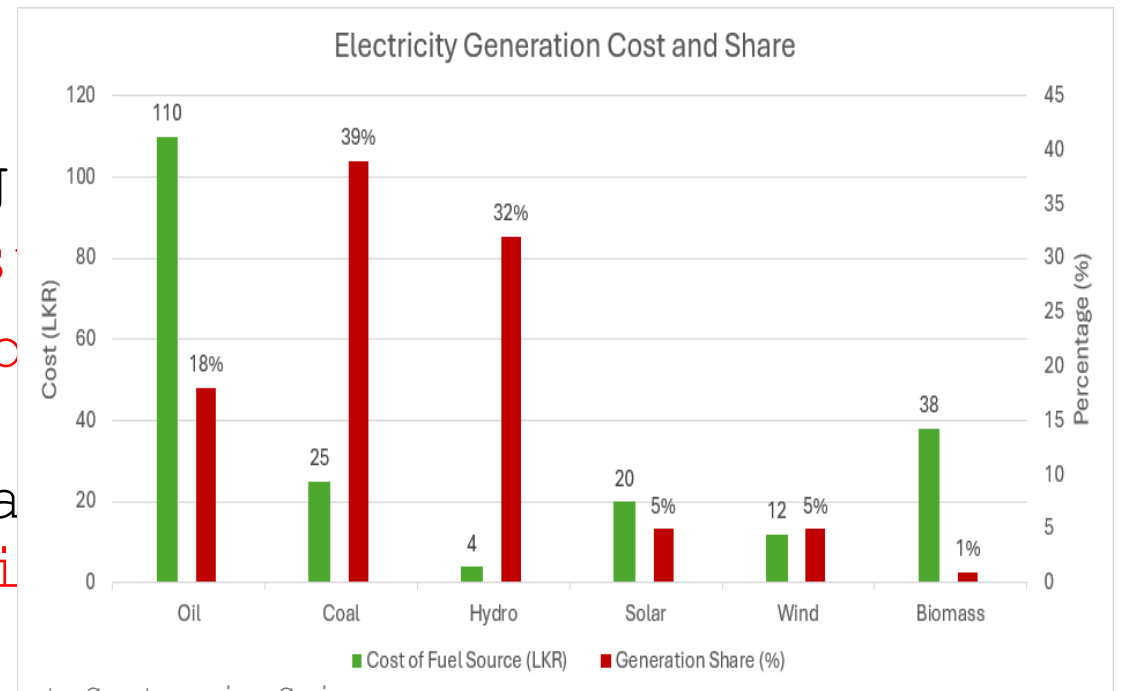
- EVs without battery costs **less** than an equivalent ICE vehicle
 - But whereas ICE requires a **low-cost petrol-tank** to store fuel (energy), EV requires an **expensive Battery** to store energy
- Can one purchase vehicles without a battery and get charged **battery** (energy) **as a service**: like petrol in a petrol pump?
 - Battery cost per km will be less than petrol cost per km
 - No waiting time to charge battery: **no charging infrastructure required**
 - Battery-life severely affected by Fast Charging at

GRID IS very dirty

mostly use coal, gas and oil to generate electricity

- Cost of electricity generation using Renewables today **less** than that from fossil fuel
 - Cost of electricity using Solar PV can be further **reduced down** significantly

- Move to electricity using renewables at the **earliest**
 - When needed, use Hydro to **b** supply and demand
 - pumped-hydro, battery storage use of **South Asia power-grid** further help



Charging Infrastructure becoming available

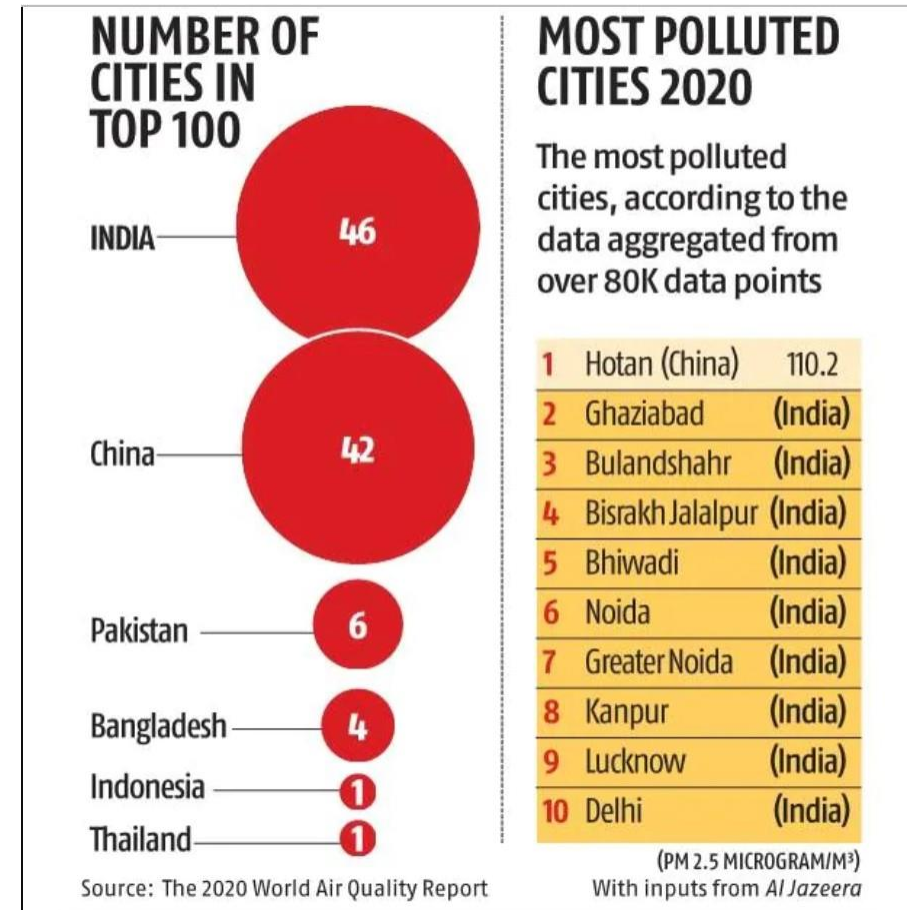
- **Home** charging (during nights) is the best option
 - **AC chargers** available at 3 kW, 7 kW, 11 kW and 22 kW at low cost: connected to single phase / three-phase power supply at homes
- Chargers being deployed in Public places: office parking, malls, highways, cinema halls
 - AC Chargers
 - **DC Fast Chargers** at 30 kW, 60 kW and 120 kW (15 to 30 minutes charging)
- Fast or Slow charging depends upon size of battery in a vehicle
 - **Slow** charging (**three-to four hours** for full charge) is **good** for battery-life
 - **Fast** Charging (**15 minutes** to an hour) ok if used occasionally
 - Vehicle with Fast Chargeable Batteries (**expensive**) can be

Battery and Solar PV will create huge waste

- Technologies **available** today for complete recycling for batteries and solar panels
 - Possible to recover **90% to 95%** raw material used and **reuse**
 - Already economically viable: a bit of **innovation** and **policy** will help
- Can be **opportunity** for Sri Lanka to recycle not just for itself but for the world

Why so much interest
in EV today?

- EV is **four-times** as energy efficient as petrol vehicles
 - PV efficiency: 22% to 23% Vs EV motor energy efficiency 90% to 95%
- Has **50 times** less moving parts
- Huge reduction in import bill



Current Status in South Asia

- EV will **dominate** market when **vehicle plus fuel for a year** costs less than that for petrol vehicles
- Electric 2W and 3W are very close: possible in another year
- 4W and small **goods** vehicle getting **established** fast: will be dominant before the end of the decade
- Larger vehicles for 300km to 500 kms haul could soon be viable

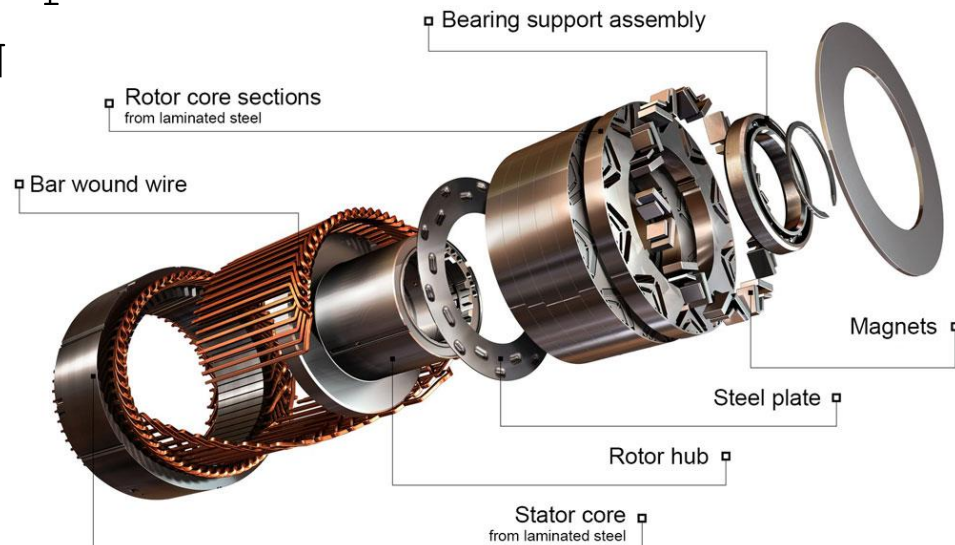
- **Long haul trucks** still in dilemma

Where can Sri Lanka
excel?

- **Large Markets** needed to drive any new Technology: Sri Lanka should work towards a **South Asia Strategy**
- Sri Lanka should however be an important **contributor** to technology and not just be a market
 - in some technology area / subsystems, it should strive to become a player
- **Battery**
 - Battery cells
 - Motors and controllers
 - DC-DC converters
 - EV Chargers
 - **Battery recycling**
 - Motors recycling
- **Green Power Generation**
 - Solar PV
 - **On-shore and off-shore Wind**
 - Hydro and **pumped-hydro**
 - Nuclear
- How did TN become the auto-capital of India?

Motors and Controllers for EVs

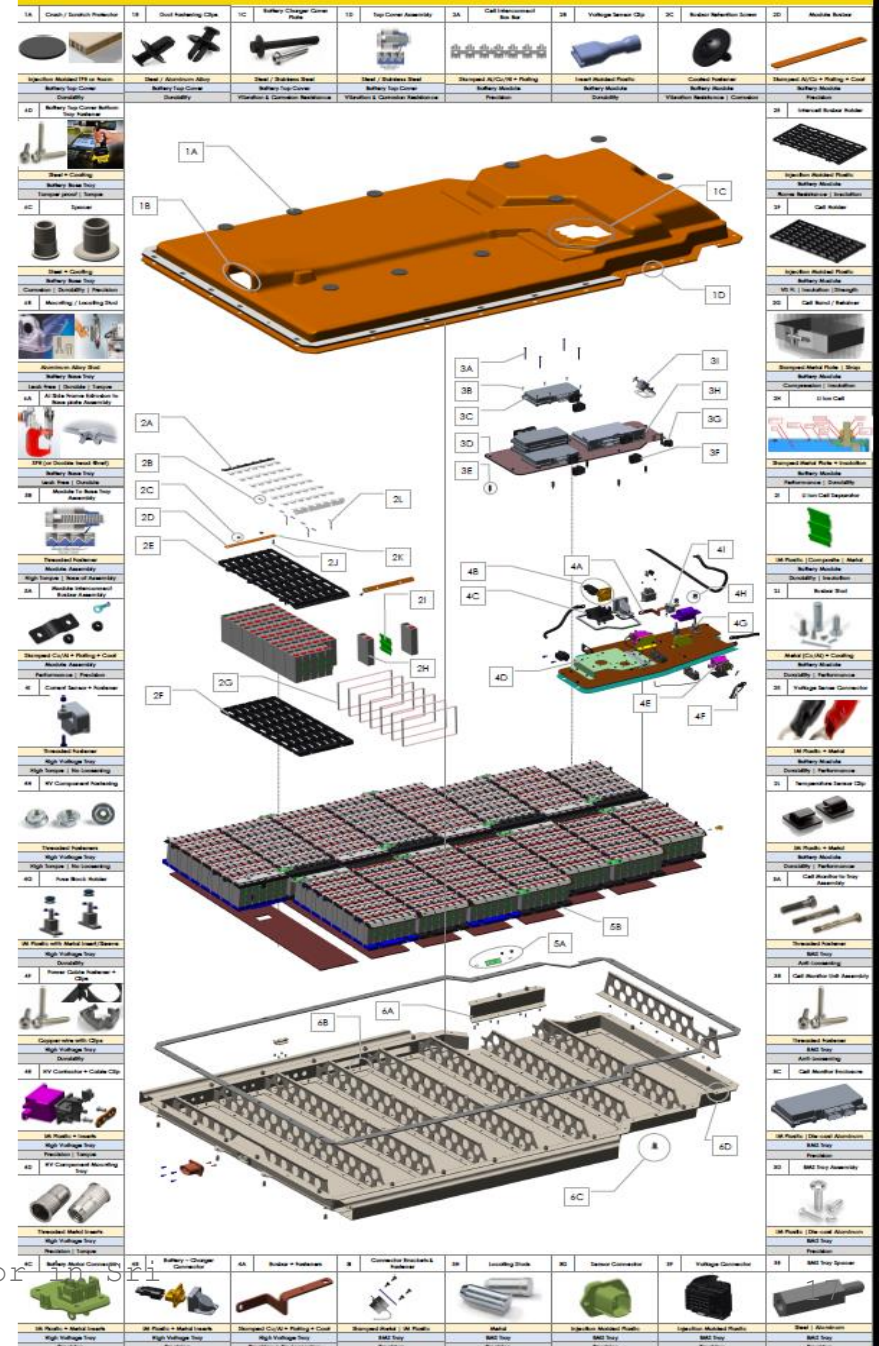
- No Gears: need entire range of speed and torque
- Voltage: 48V / 72V / 350V/ 700V
- High current: few hundred Amps
- N



- Induction Motor
 - Do not have enough starting torque: Oversized motor required
 - Lower efficiency
- PMSM
 - Axial flux (more compact)
 - Hub motors (2-wheelers)
- Tomorrow
 - Rare-earth free (with Ferrites)
 - Magnet-free (Switched and Synchronous reluctance motors)
 - Large size

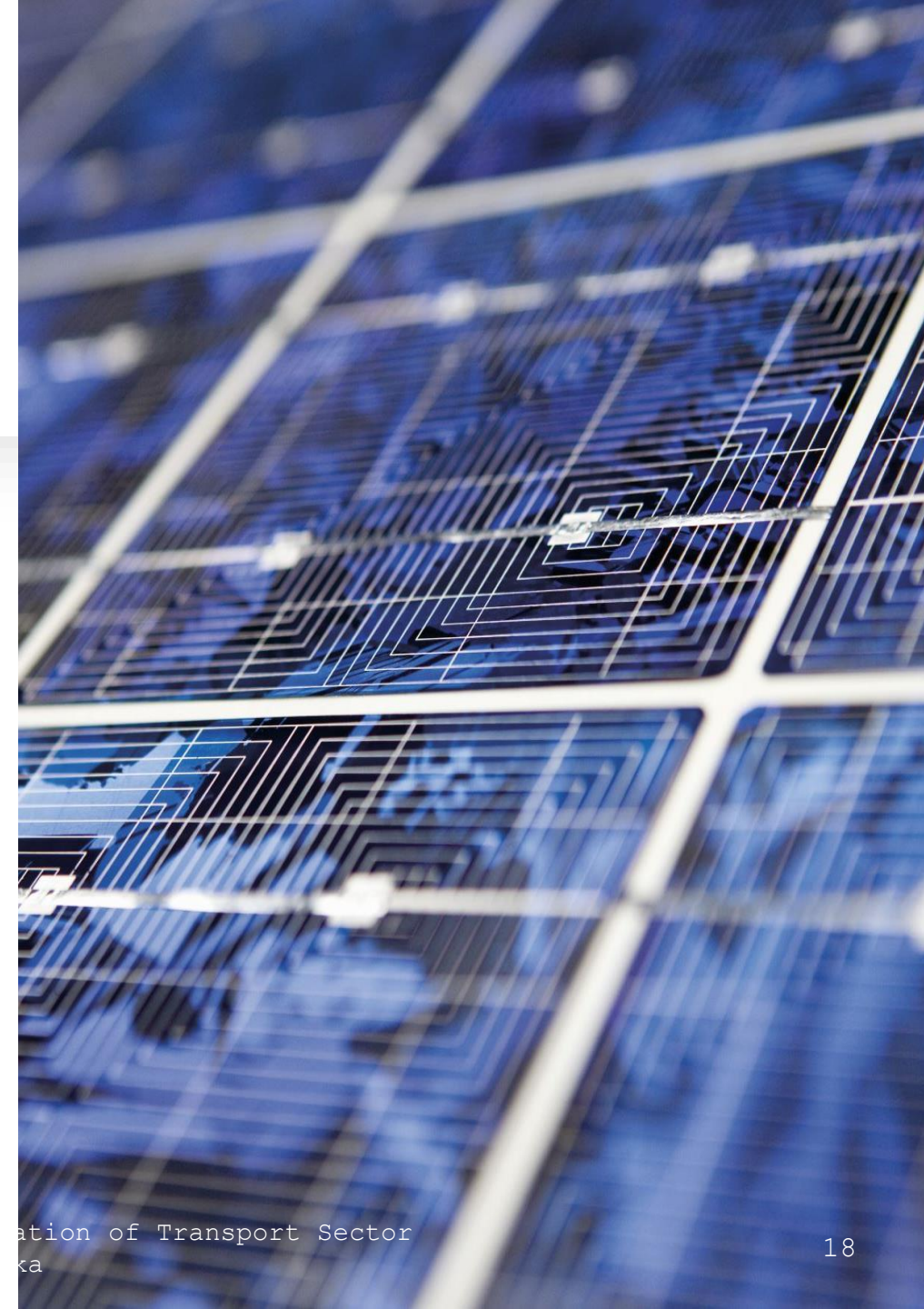
BATTERY SYSTEM COMPONENTS

- Battery-pack manufacturing involves large number of **components**
 - Large number of **ancillary** industry
 - Large number of jobs
- Need to be designed for South Asia's environment conditions
 - Involves quality **thermal** design
 - Careful **mechanical** design
 - BMS to ensure cell life **maximised** and safe operations under all conditions



To Sum Up

- Sri Lanka needs to move to EV rapidly to free its **economy** from impact of large oil-imports
 - Technology is ready
 - Need aggressive local industry
 - Some R&D and Innovation
 - Need right policy
- Sri Lanka's electricity generation should move **fully** to renewables
 - Will help national and global **environment**
 - Will help Sri Lankan Economy



Finally, Can Sri Lanka be a leader

In alternate transport for congested cities
office ↔ home commute often exceed 60 min each way:
reduce to **20 min**

Electrification, but also overcoming Congestion

- Public Transport with a difference: personalized pod anywhere to anywhere, comfortable, energy-efficient, using green electricity,
 - Built on existing city-infra, Affordable



- HASHTIC

- Autonomous point-to-point public transportation system
- Large no of alternate routes: chosen to move POD at 75 kmph average (no stopping and no crossing)

