Decarbonising Transport through Electrification, A whole system approach Network+

Professor Liana Cipcigan

Principal Investigator

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https://dte.network

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Cranfield University

DTE Network+ Message

DTE Network

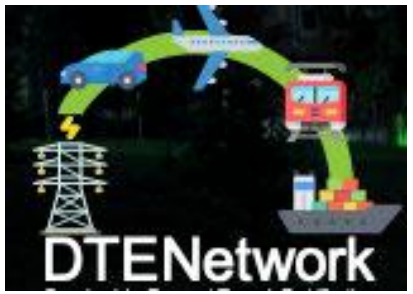
Engineering and Physical Sciences Research Council

Identify and address challenges for electrification of transport.

DecarboN8: An Integrated Network to Decarbonise Transport

Decarbonising UK Freight Transport

Decarbonising UK Freight Transport



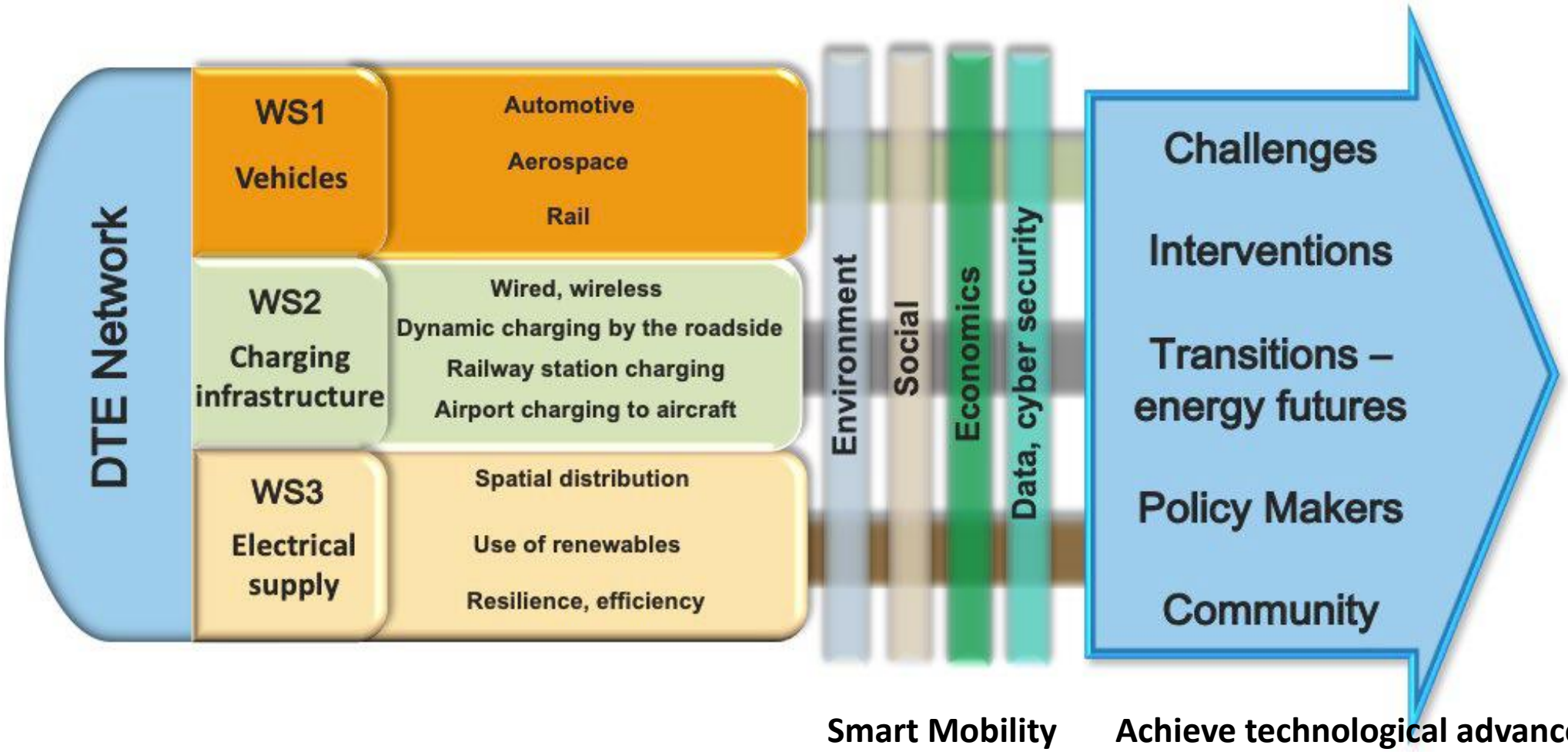
DTE a Whole System Approach

Network-H2: A Network for Hydrogen-Fuelled Tansportation

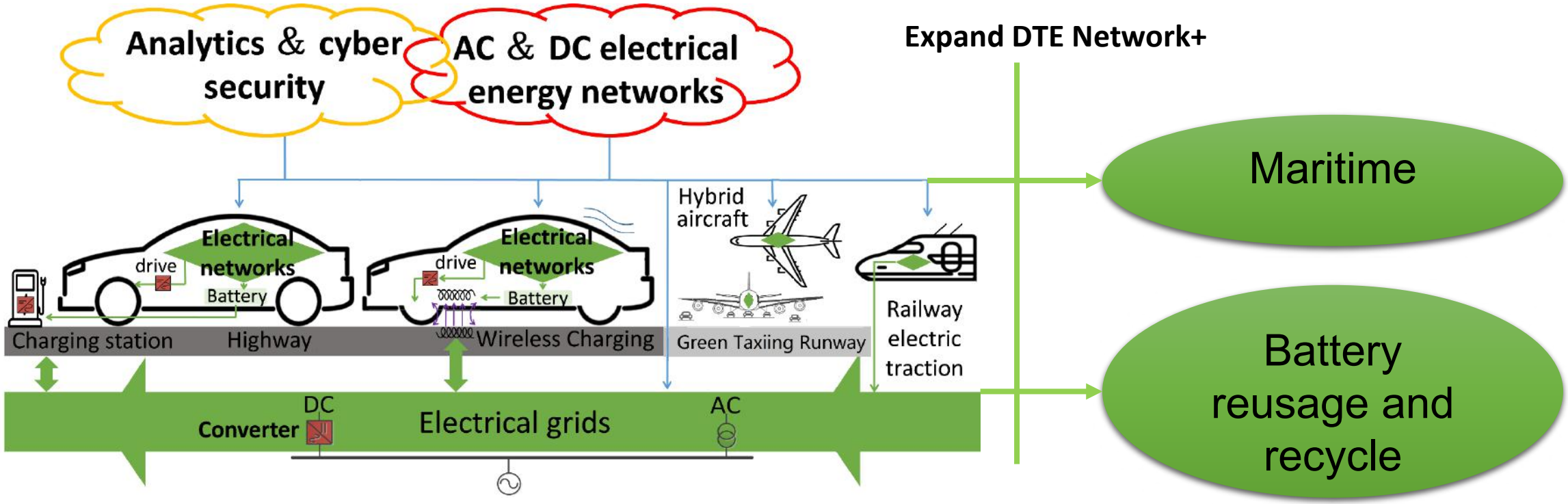
NewJet: Low carbon technologies for aviation

DTE Network+ Message

Identify and address challenges for electrification of transport.



Integrated Whole System Approach



Road Transport Short to Medium Term Challenges

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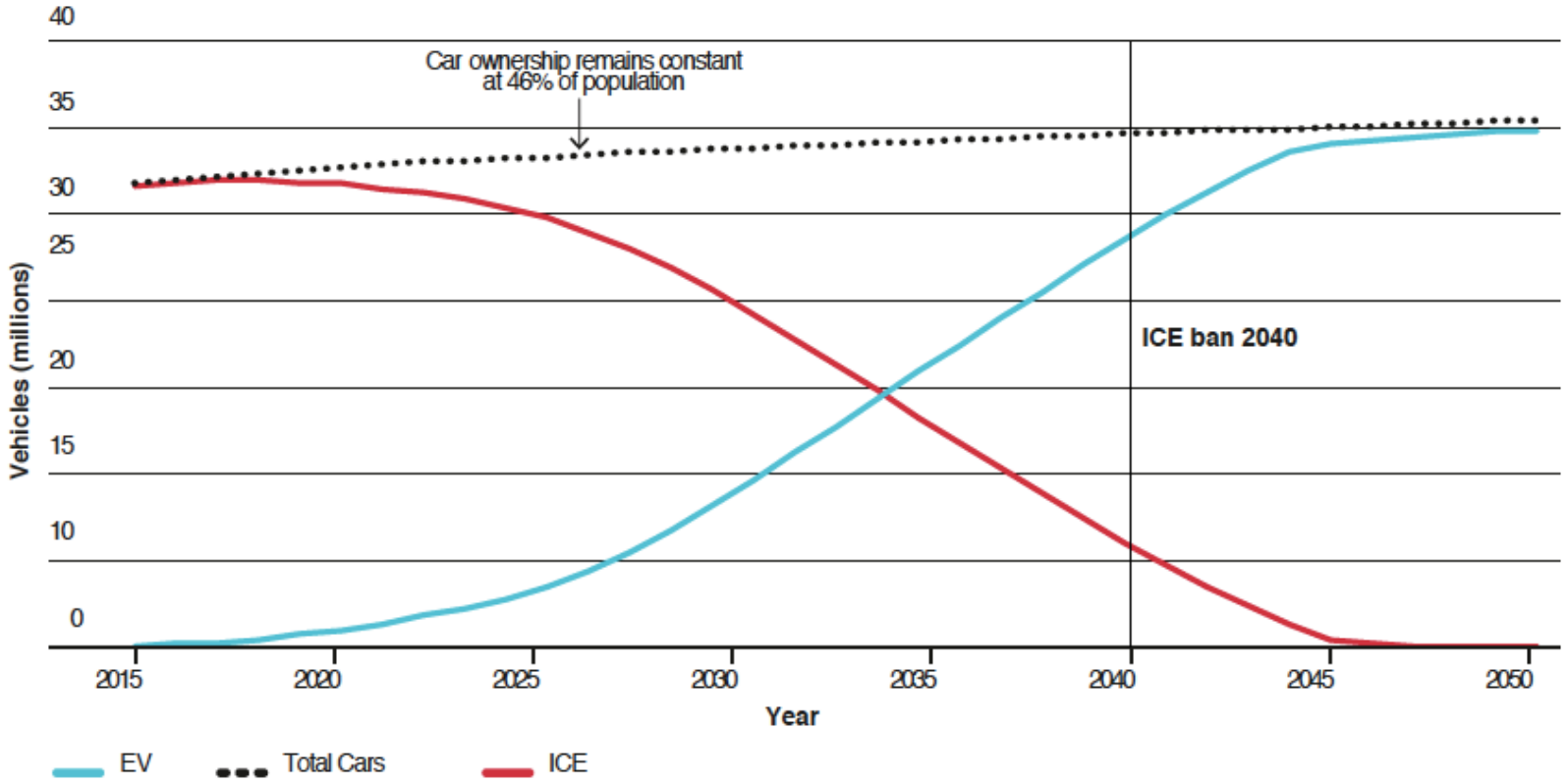

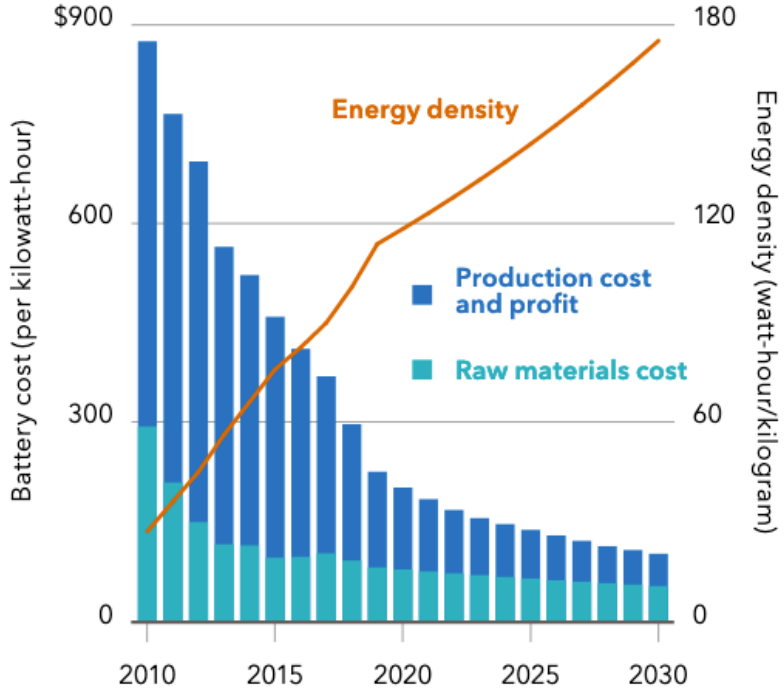

https://www.blackrock.com/corporate/literature/whitepaper/bii-future-of-vehicle-2017-international.pdf

nationalgrid

Road Transport Short to Medium Term Challenges

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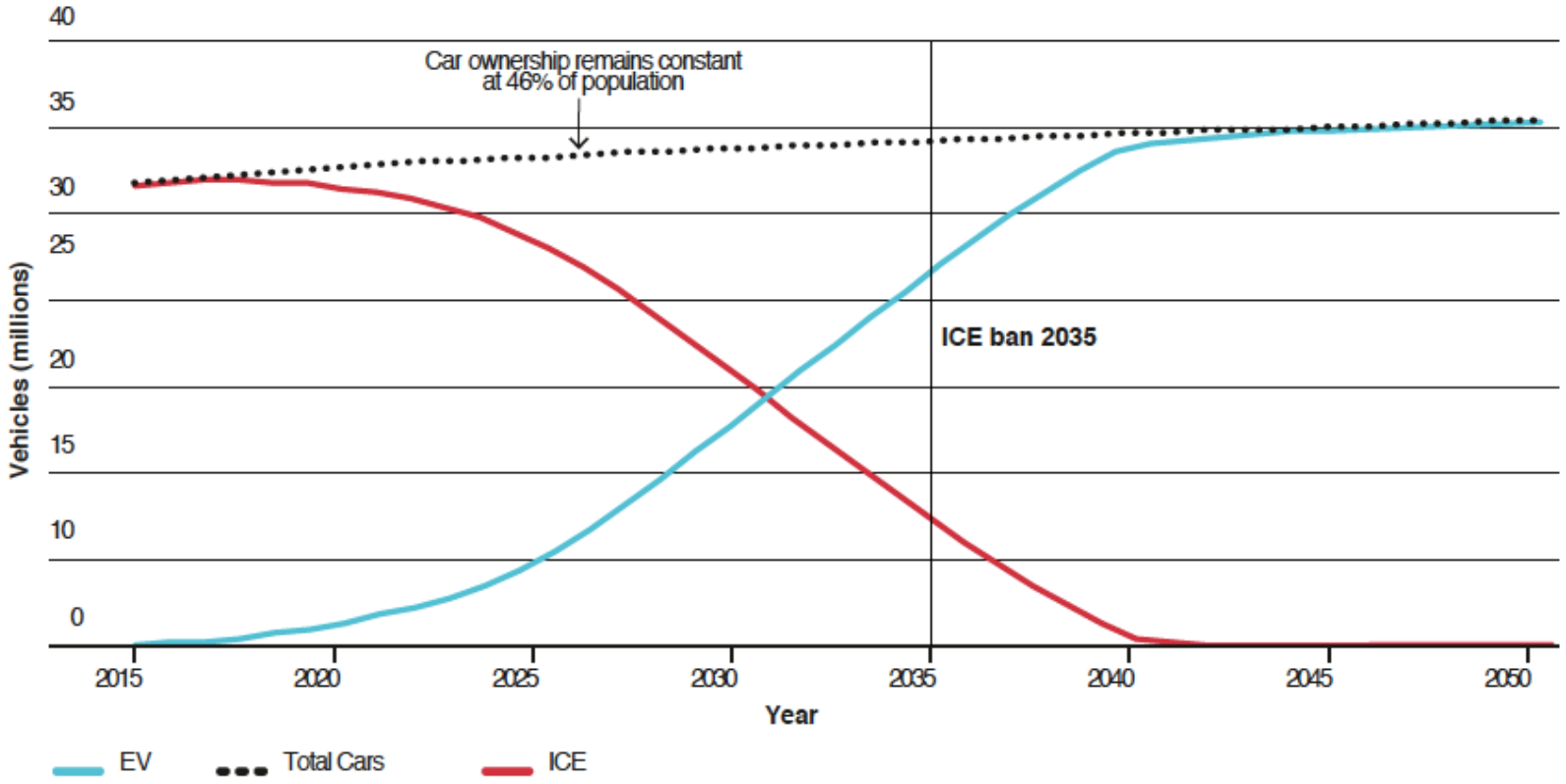

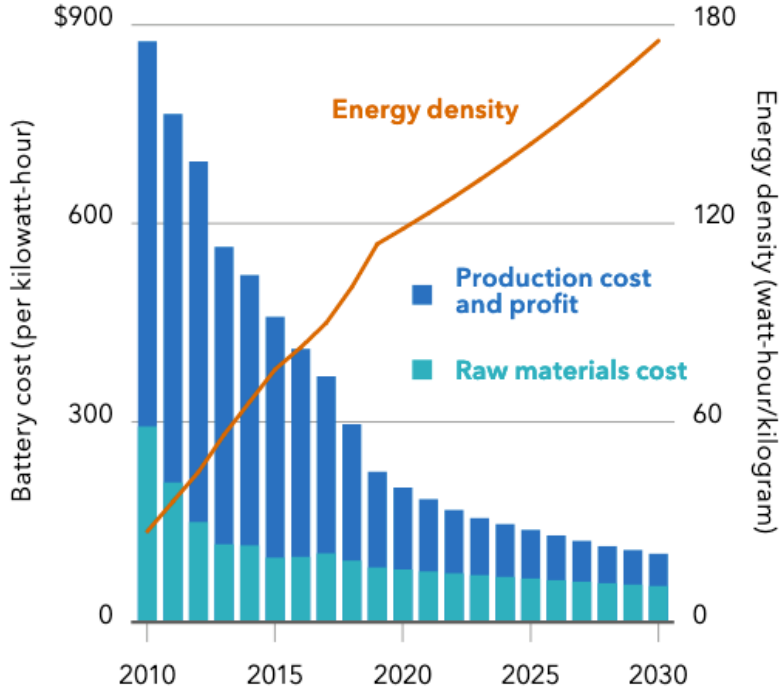

https://www.blackrock.com/corporate/literature/whitepaper/bii-future-of-vehicle-2017-international.pdf

Expand the DTE Network+ Pilot Projects

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Allocated £400k to fund pilot projects and feasibility studies

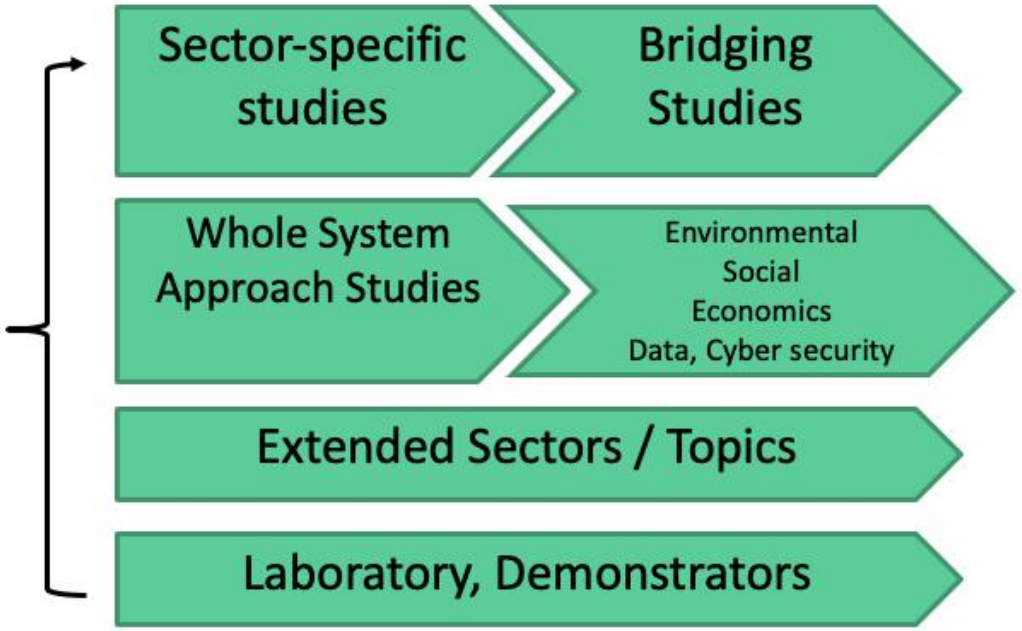
	Number of projects	Budget (80% FEC)	Duration
Year 1	3 projects	£30k / project	Up to 6 months
Year 2	4 projects	£50k / project	Up to 8 months
Year 3	2 projects	£50k /project	Up to 6 months

Funding can cover:

- UK-based academic salary costs
- Stakeholder engagement events
- Travel and subsistence
- Dissemination costs

Funding is for academic research teams **lead by UK universities**

Industrial Partnership Co-funding



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Project Team

Engineering and Physical Sciences Research Council

Prof Liana Cipcigan
PI

Prof Patrick Luk
Leader WS1

Dr. Pietro Tricoli
Leader WS2

Prof. Manu Haddad
Leader WS3

Prof. Carol Featherston
Leader Smart Mobility

Prof. Jun Liang
Leader WS4

Prof. Xibo Yuan
PI Bristol Univ.

Prof. John Preston
PI Southampton Univ.

Prof. Omer Rana

Dr. Dimitrios Potoglou

Dr. Georgina Santos

Dr. Phil Morgan

Stakeholders Partners

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People based activities

Prof. Jun Liang

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People Based Activities

Work Stream 4 Network events and people-based activities

Network-wide events and activities

- Themed workshops
- Keynote speeches
- Industrial Days
- Sandpit activities
- Industry-Academia dissemination events
- Communication of the project research & activities.

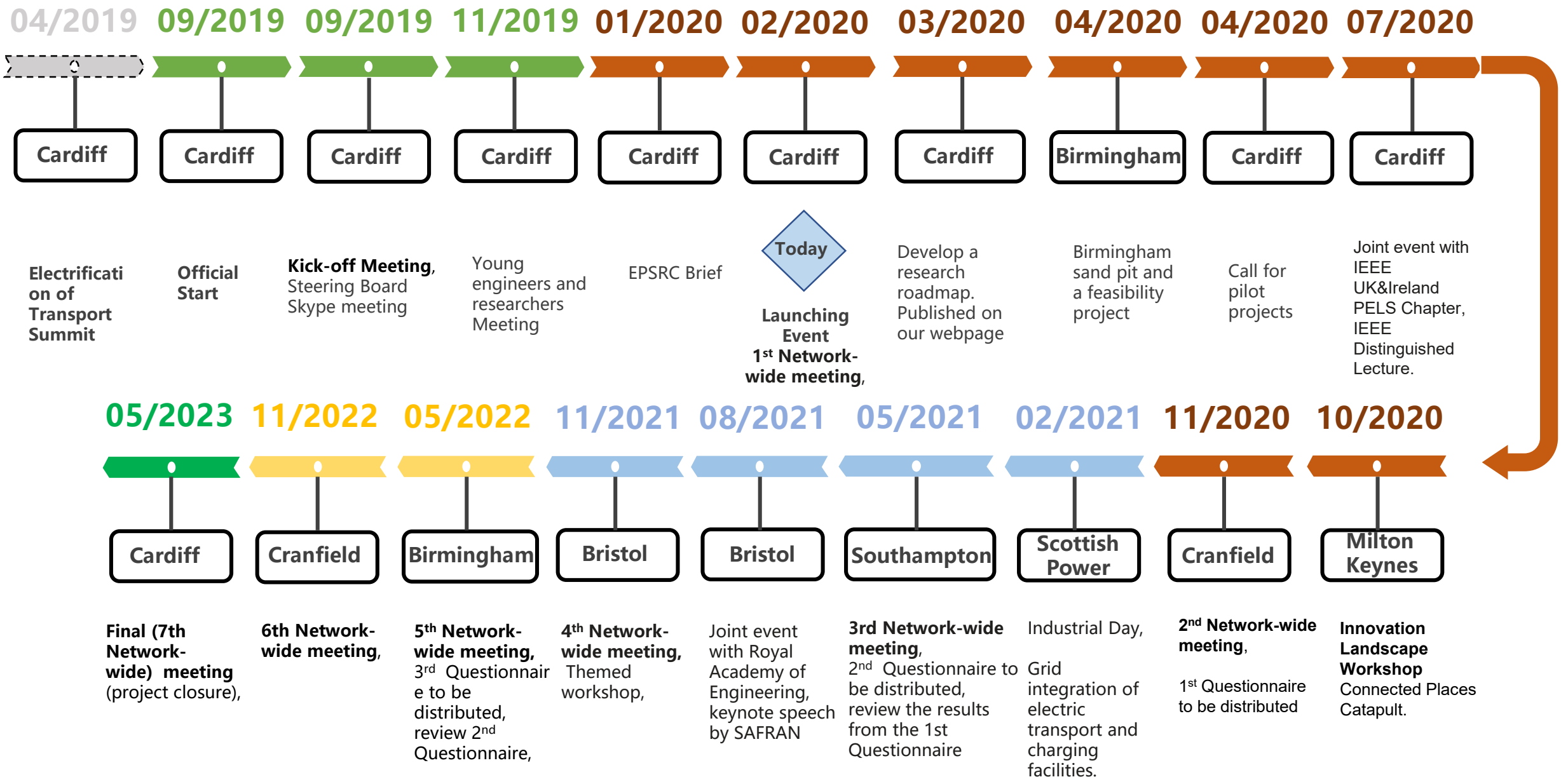
Wide impact and outreach events:

- Presentations at various external events.
- Student competition
- Targeted conferences.
- Joint events
- Jam events.
- An international conference

Management of the feasibility fund

- Sandpit.
- Questionnaires
- Identification of the topics,
- Call and award
- Monitoring of the progress.

Timeline of network-wide/impact events and locations



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Work Stream 1:

Vehicle and Associated Technologies

Presented by Dr Xin Zhang

Cranfield Team Members: Prof Patrick Luk (lead), Dr Xin Zhang, Dr Criag Lawson, Prof Antonios Tsourdos, Prof Howard Smith

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Cranfield's Air Transport infrastructures

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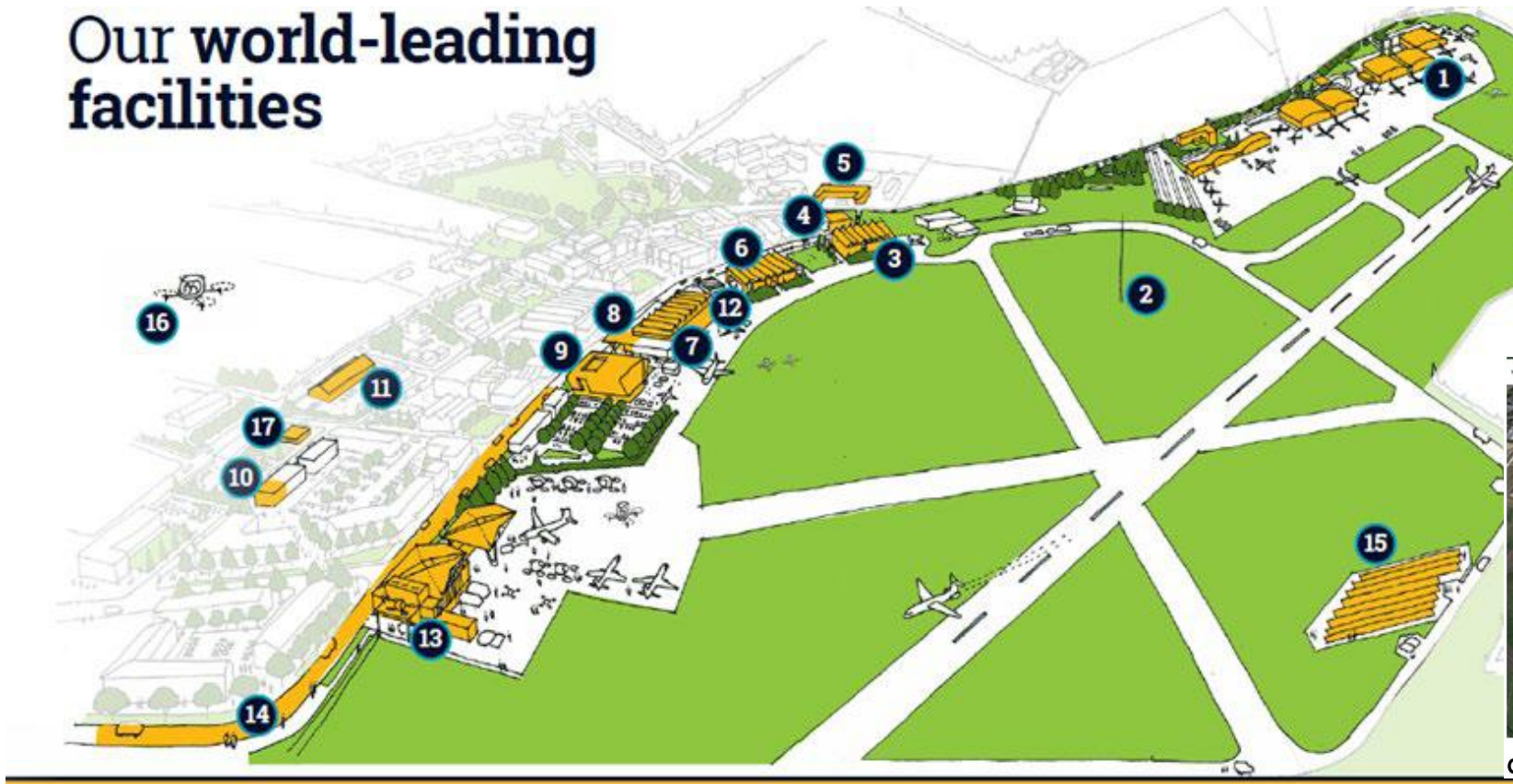
Our world-leading facilities



1. Air Park (detailed planning permission obtained)
2. Digital mast
3. Cranfield Airport
4. Home to Facility for Airborne Atmospheric Measurements (FAAM)
5. Cranfield Management Development Centre (CMDC)
6. Cranfield Aerospace Solutions Ltd
7. Centre for Aeronautics
8. Intelligent Mobility Engineering Centre (IMEC)
9. Aerospace Integration Research Centre (AIRC)
10. Digital Air Traffic Control Centre
11. Safety and Accident Investigation (SAI) Centre
12. National Flying Laboratory Centre (NFLC)
13. Digital Aviation Research and Technology Centre (DARTeC)
14. Multi-User Environment for Autonomous Vehicle Innovation (MUEAVI) Road
15. Solar Array
16. National Beyond Visual Line of Sight Experimentation Corridor (NBEC)
17. Barclays 'AvTech' Eagle Lab

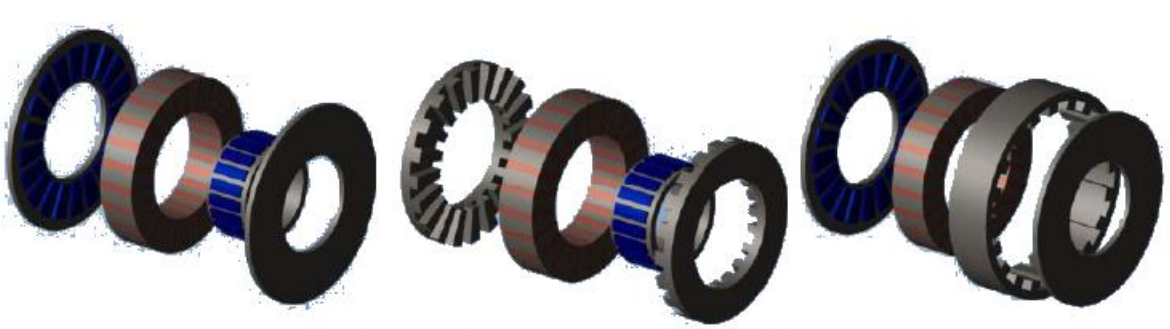
Cranfield Airfield and 1 MW PV farm (source: Google map)

Research Question

How to address the aviation transport challenges (Flightpath 2050 Vision):

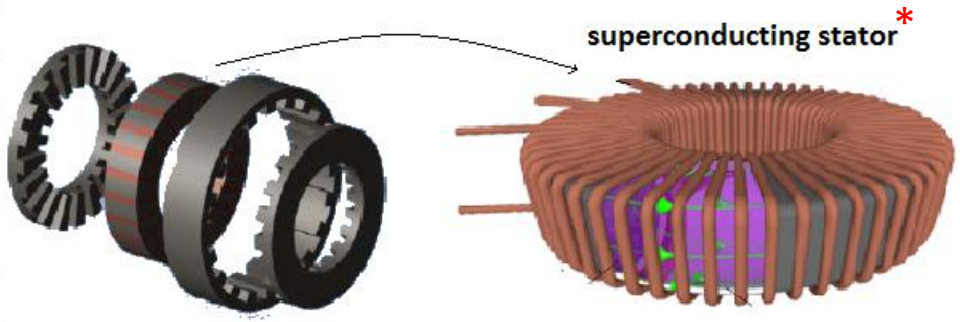
- 75% reduction in CO2, 90% reduction in NOx, 65% reduction in noise (2000 base line)
- All aircraft ground movements are emission-free
- 90% of travellers within Europe are able to complete their journey, door-to-door within 4 hours.

Theme 1. Electric Powertrains – A modular topology



Power density (1- 5 kW/kg)

Traction motors for electric vehicles



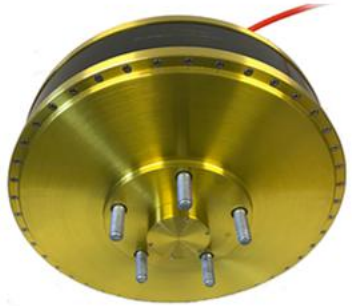
Power density (10-50 kW/kg)

Propulsion motors for aircraft, ships and trains

*P.C.K. Luk, "Superconducting machines — The enabling technology for future electric propulsion in aircraft", IEEE International Conference on Power Electronics Systems and Applications - Smart Mobility, Power Transfer & Security, Dec 2017, pp1-7

Theme 2: Connected Autonomous Vehicles – A Modular framework

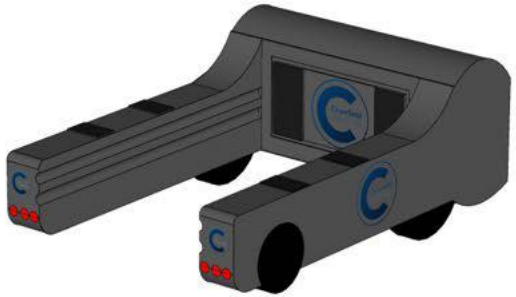
(a) Autonomous motor-driven platform



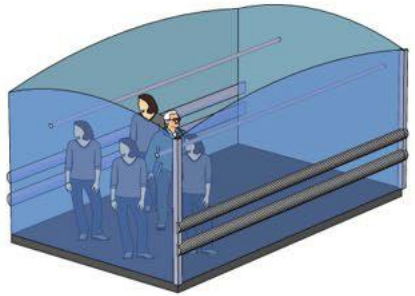
(b) Rare-earth PM in-wheel motor

(c) Ferrite traction PM motor

Cranfield's Modular Autonomous Electrified Platform and the Traction Motor Technologies



(a) Autonomous motor-driven platform

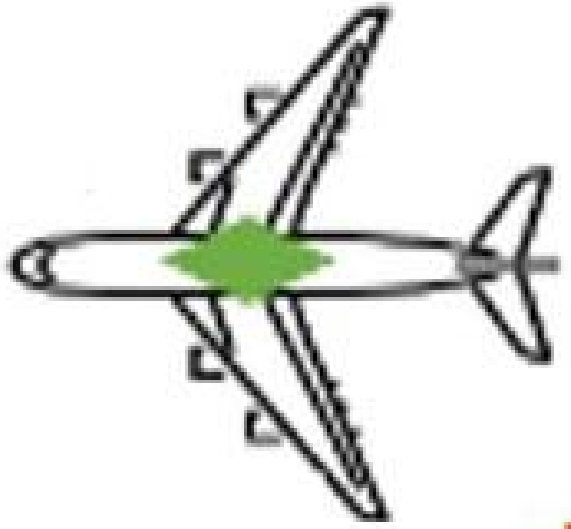


(b) People mover capsule

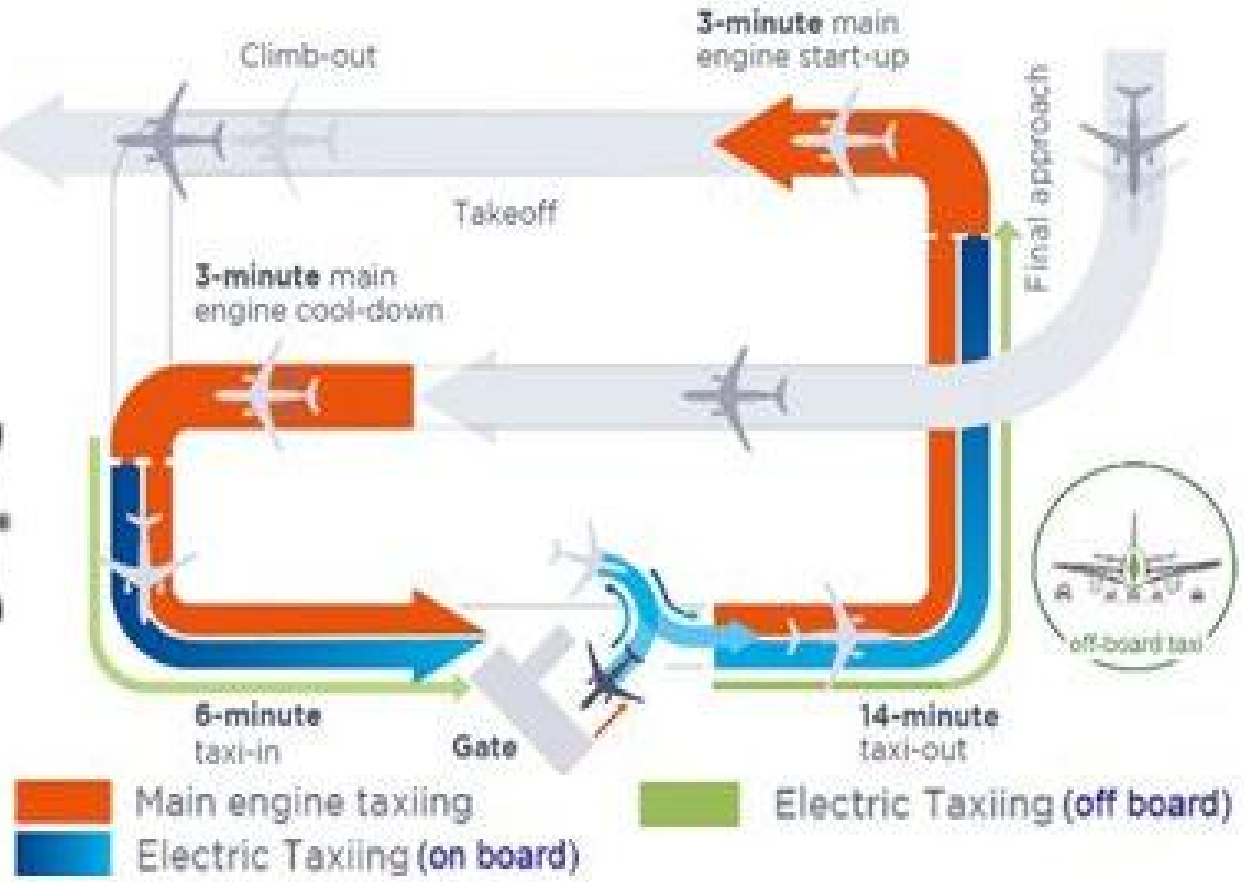
(c) Cargo capsule

Mobility as a Service (MaaS)

Theme 3: Green Taxiing As Technology Demonstrator



(a) Small electric/ hybrid aircraft



(b) Electric taxiing - On-board & off-board

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Work Stream 2: Charging infrastructure

Dr Pietro Tricoli
Department of Electronic, Electrical and Systems Engineering
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Birmingham Centre for Railway Research and Education

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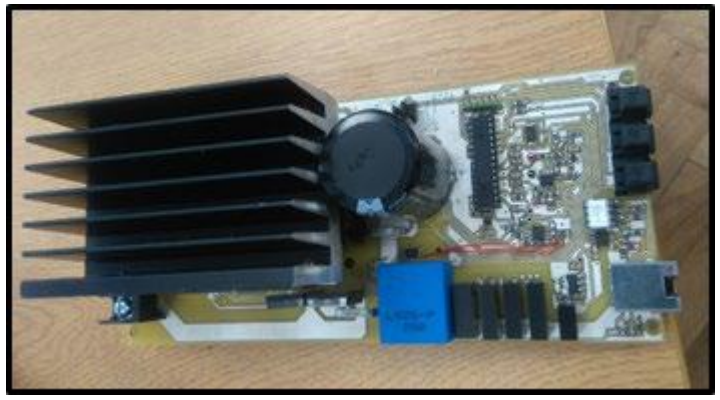
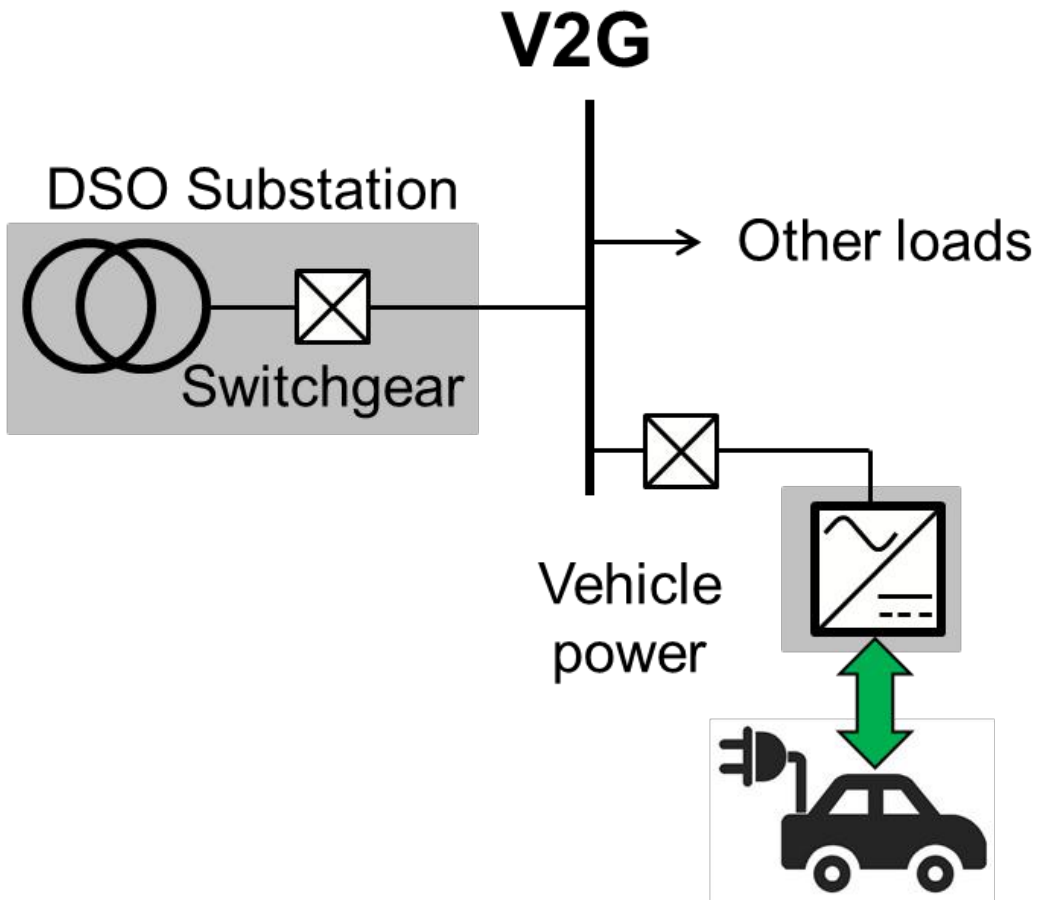
- Power Electronics Laboratory
- Energy Systems Integration Laboratory



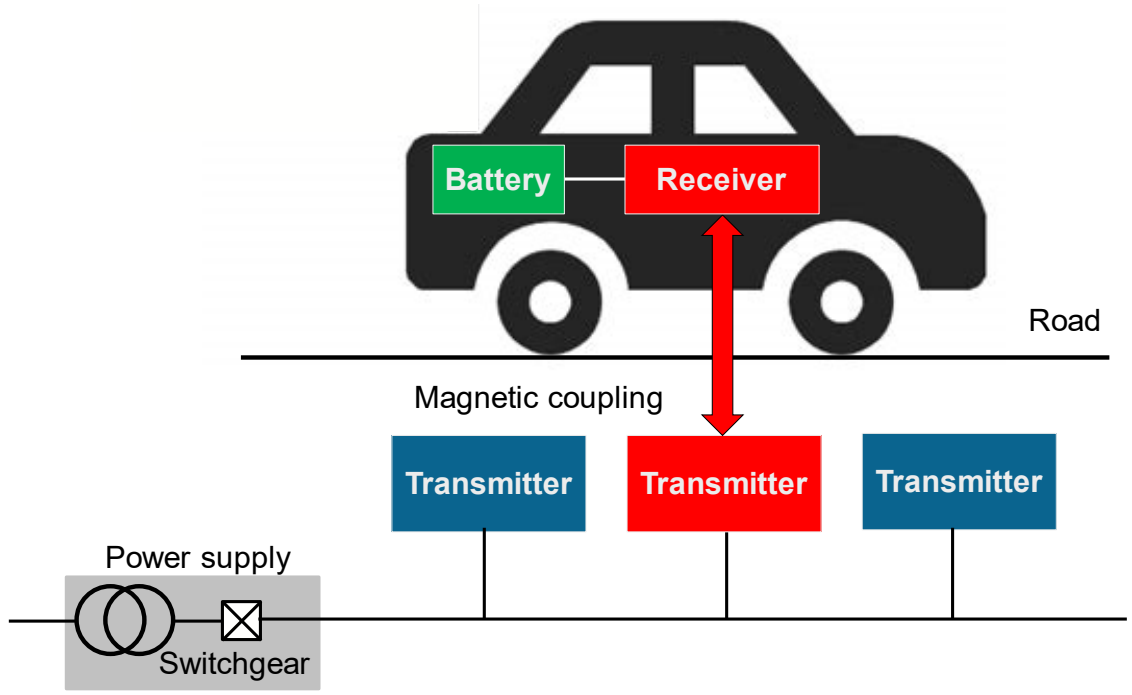
Extending and building charging infrastructure

- Development of charging and/or fuelling infrastructure for EVs
  - Development of (smart) integration of these vehicles with grid capacity (V2G)
  - Flexible demand and energy storage
- Enable the integration of autonomous land and air vehicles
- Analysis of regional disparity for charging infrastructure (spatial urban planning versus rural, population density)



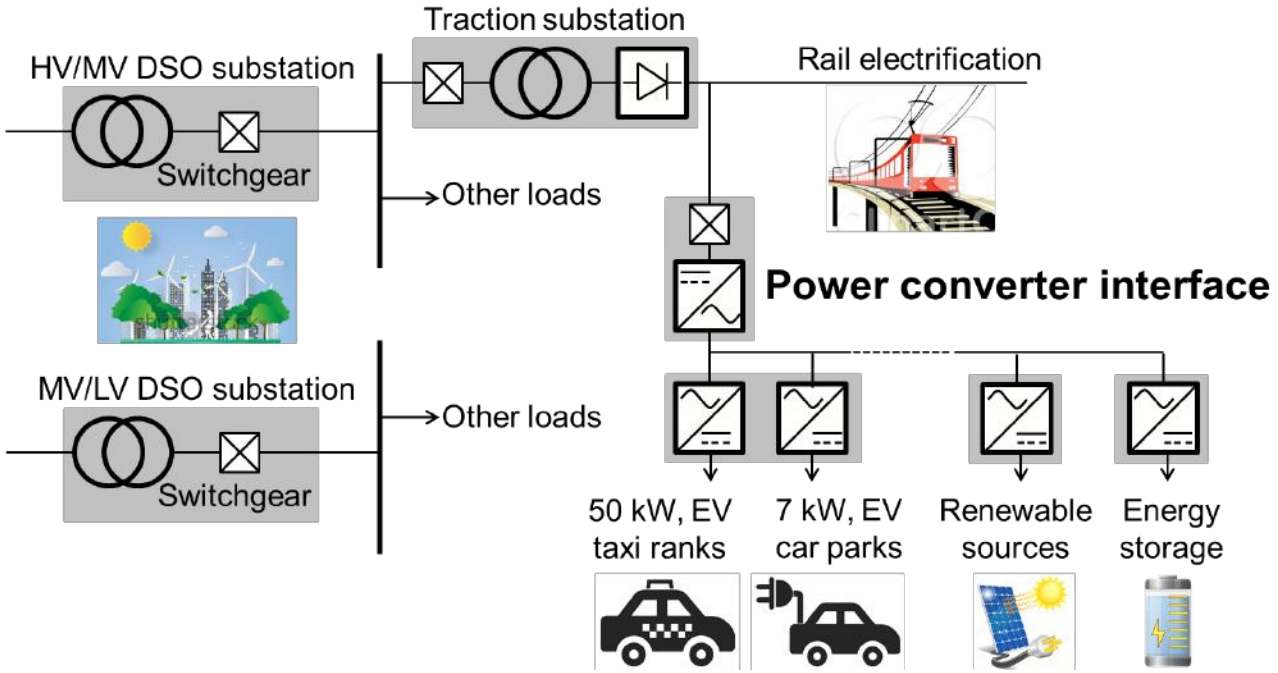
Static and dynamic charging on the road

- Distribution / transmission network requirements for dynamic charging
- Magnetic design topologies and their performances
- Demand patterns for dynamic charging and impact on the grid
- Safety issues.
- Converter topologies, control and protection;



Railway feeder stations

- Use of railway feeder stations in integrated mobility concept
  - Railway stations fitted with EVs charging
  - Combined tickets for rail transport and EV charging
- Railway feeder stations as a key component of smart grids to aid the storage and optimised use of electricity.
  - Understanding the energy/electricity requirements.
  - Use of access and egress modes and energy/electricity requirements.
- New semiconductor materials for converter design and reliability



Integration of low carbon generation on the railway electrification network

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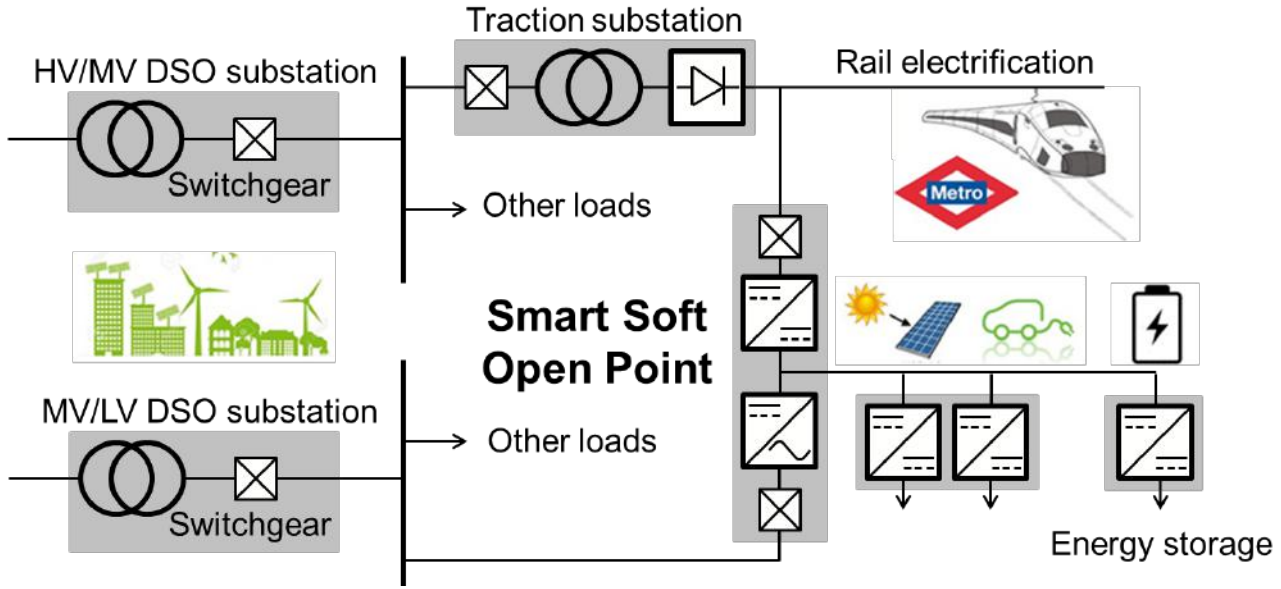
- New grid architectures
  - Medium voltage DC traction power supply systems
  - Connection of energy storage and renewable sources
- Implementation of smart grids concepts
  - Technologies based on Smart Soft Open Points for the reduction of power losses
  - Control of power flows with the power distribution grids
- DC networks for charging facilities and related research/devices



EUROPEAN COMMISSION
Grant agreement no. 774392

e-lobster

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Work Stream 3: Supply of electricity as a transport fuel

Prof. Manu Haddad

School of Engineering, Cardiff University

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Successful transport decarbonisation through electricity

Needs to:

- Ensure electricity generation mix is also decarbonised to avoid shifting emissions from transport to electricity generation
- Address short, medium and long term challenges for future electricity networks infrastructure (generation, transmission and distribution)
- Meet demand from electric transport (currently some 40m vehicles on the road consuming **46 billion litres** of fuel, only 250,000 EVs)

The 2035 challenge for electricity networks is to supply additional electrical power to

Fixed/known connection points for

- Rail: along the tracks of electrified lines
- Aerospace: at airports and future urban flying points
- Maritime: at ports / along waterways

Highly distributed charging points for EVs

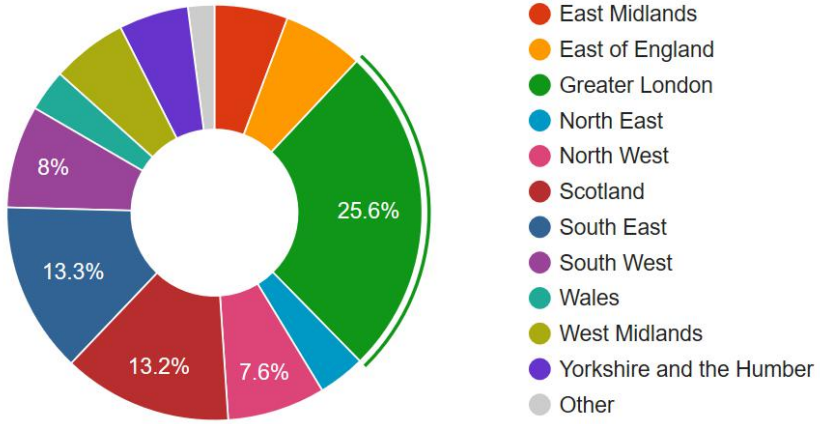
- Large number of charging points to be connected (replace existing petrol stations)
- Domestic, industrial and built-up areas: charging points may require local network reinforcements





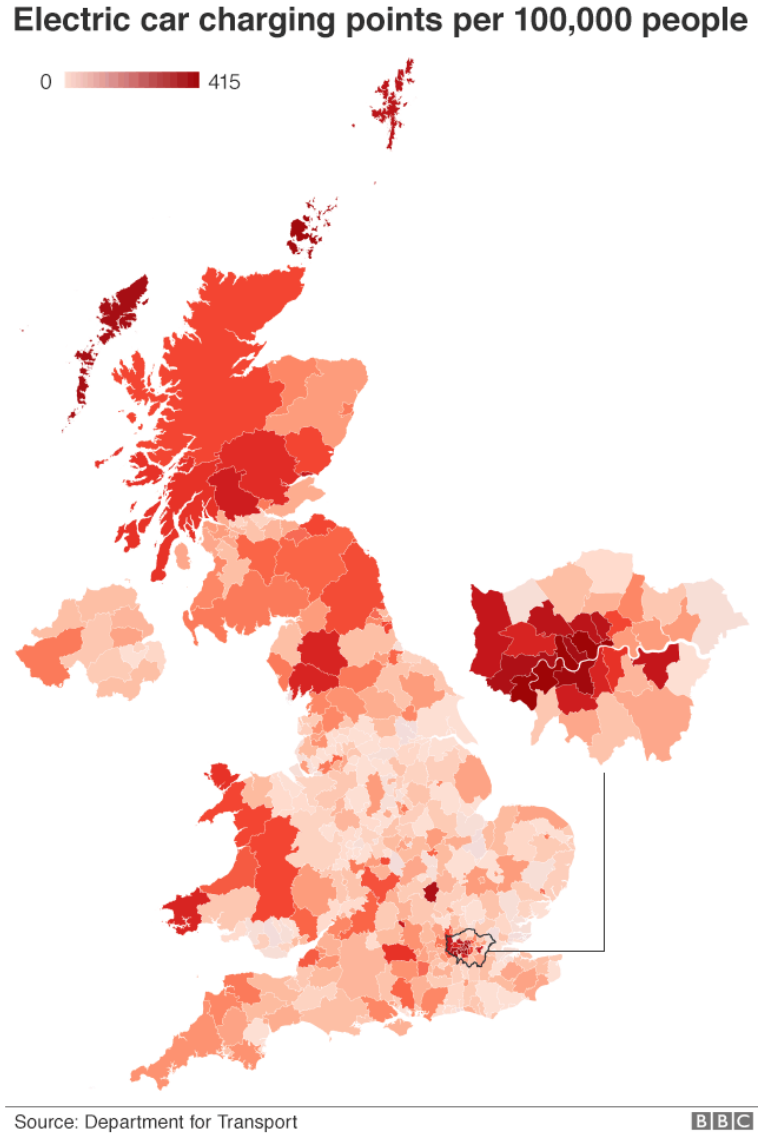

Meeting the EV charging challenge

Profile of charging connectors across the UK regions: Zap-Map, February 2020



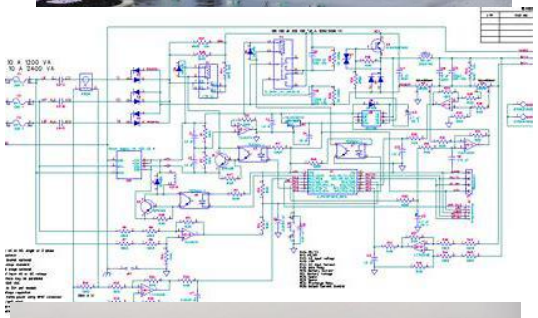
Total connectors: 30808

ZAP MAP



Some of the research questions

- Increase and optimise use of **renewables** to reduce carbon emissions,
- exploit local energy generation, storage and management systems
- Geographical distribution / re-distribution of electricity demand with electric transport,
- Integrate charging infrastructure, power electronics penetration and HVDC power grids: address control and power quality and full grid integration
- Balance of electricity demand and EVs to be used as a source of flexibility and storage (bi-directional power flow at charging points)
- Design and build a reliable network infrastructure to satisfy requirements of future electrification of transport allowing connections at all voltage levels to charging points and new renewable generation plants



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Smart Mobility

Prof Carol Featherston

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Smart Mobility

> "the future is going to be increasingly more autonomous, more electric, more connected and shared,"

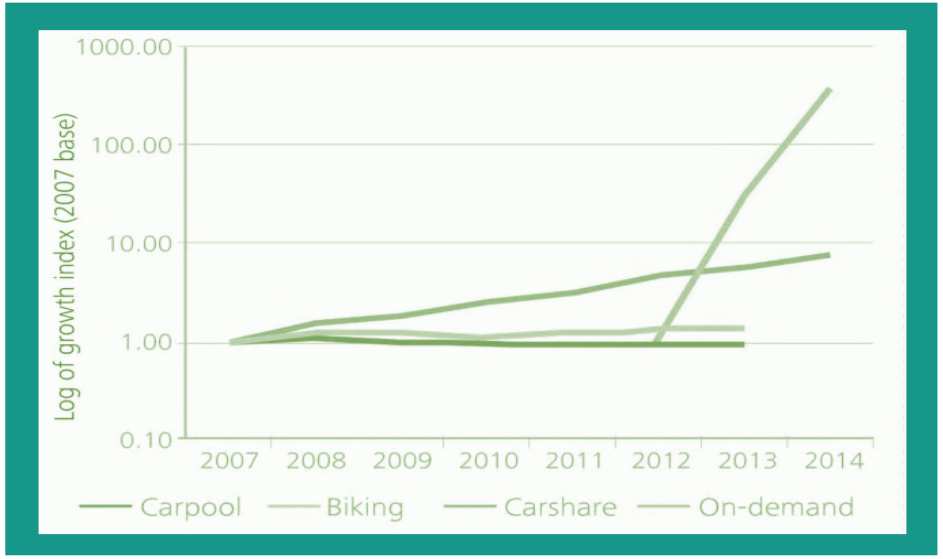
Laurens van den Acker, Renault

In 2010 the number of vehicles on the planet reached 1 billion. This is predicted to double by 2030.

We need a holistic approach enabling transport systems to cope with changing technology capabilities, social expectations, and economic and environmental priorities.

Flexible → Efficient → Integrated → Clean → Safe → Smart Mobility

Smart Mobility



Growth rates for alternative transit modes
Deloitte University Press I DUPress.com

- New business models for a shared economy
- Product manufacturers to mobility services companies
- An expanded mobility ecosystem to advance public policy goals
- Alternative transportation modes

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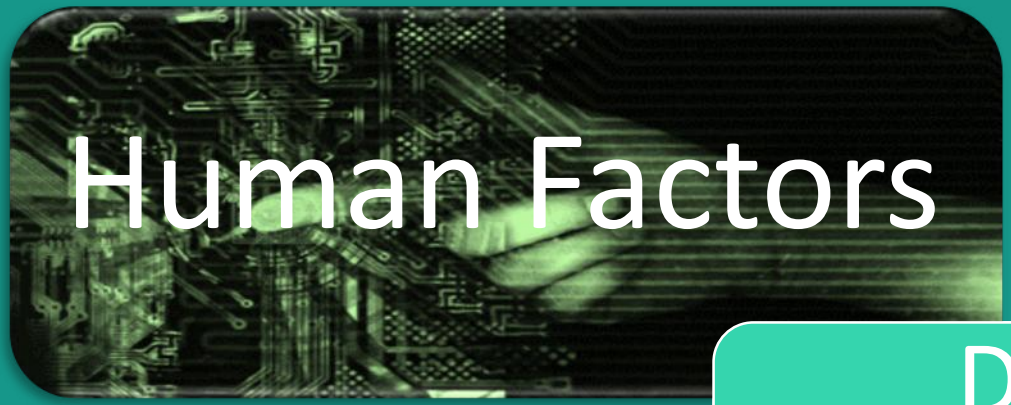
Smart Mobility



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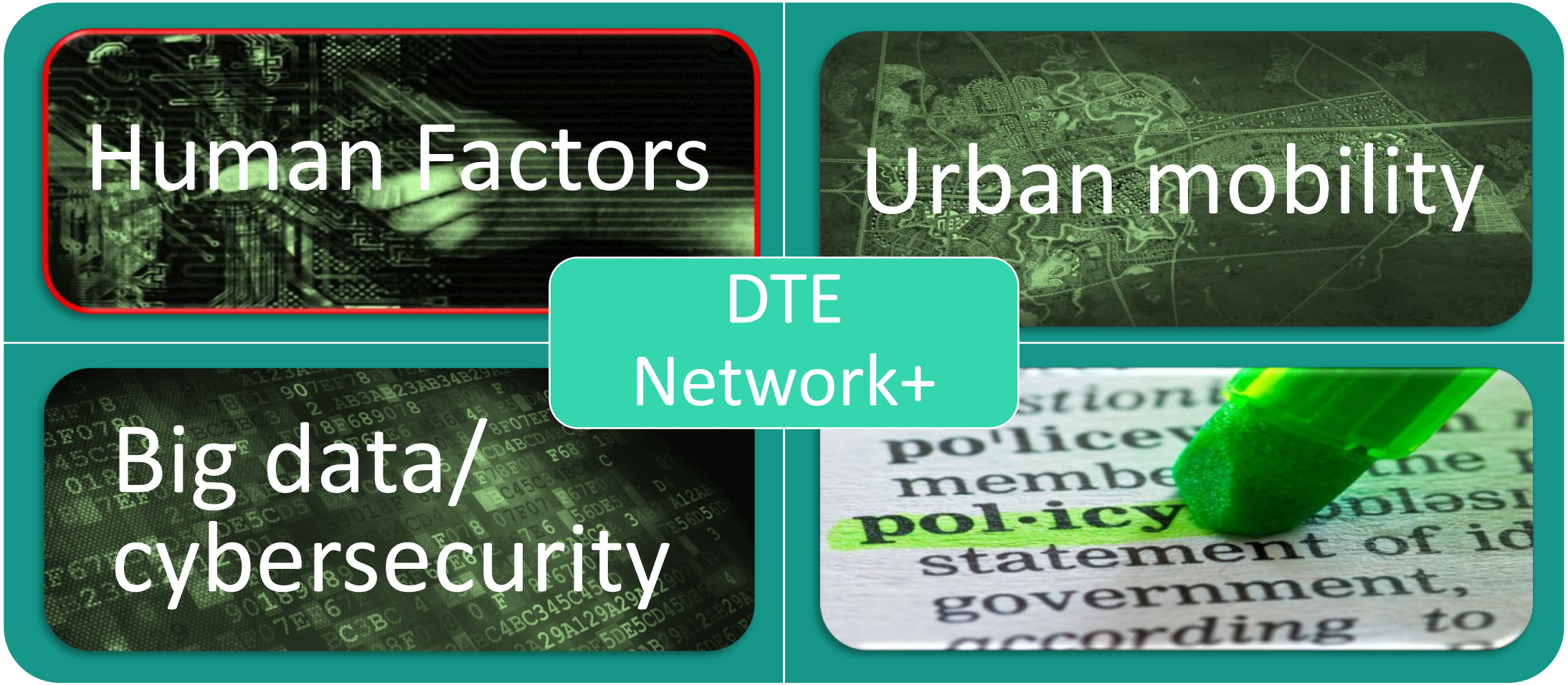

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Smart Mobility

How we change our relationship with and use of vehicles ?

Urban mobility

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Big data/ cybersecurity

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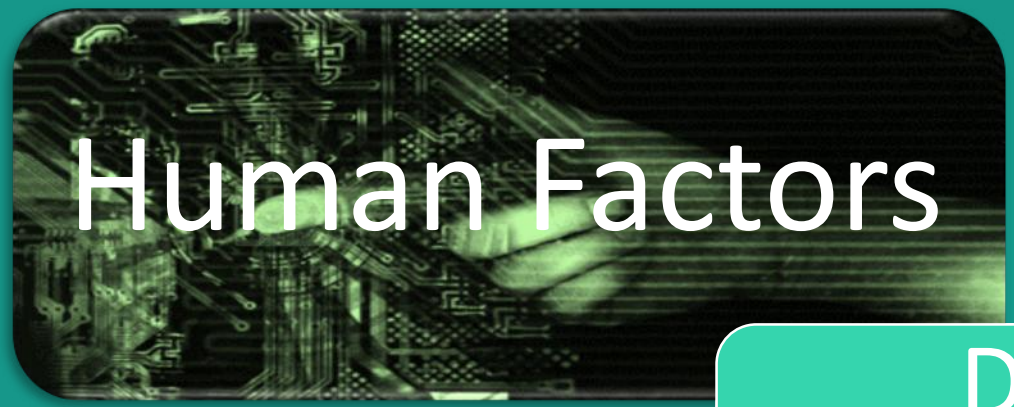

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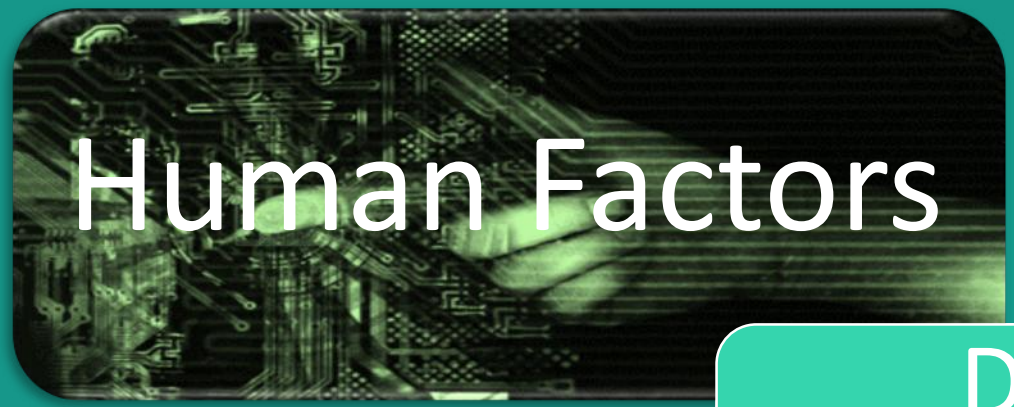

How do we foster balanced development of all transport modes ?

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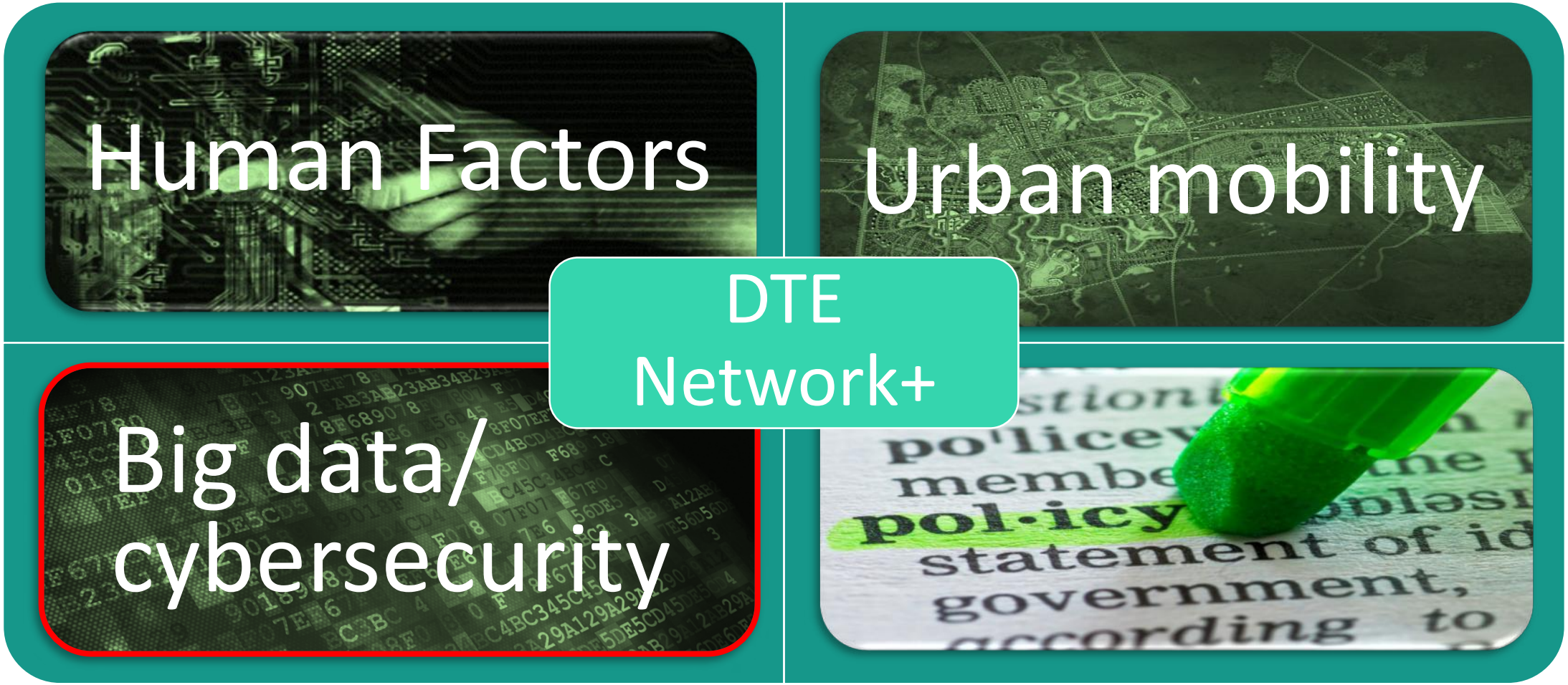
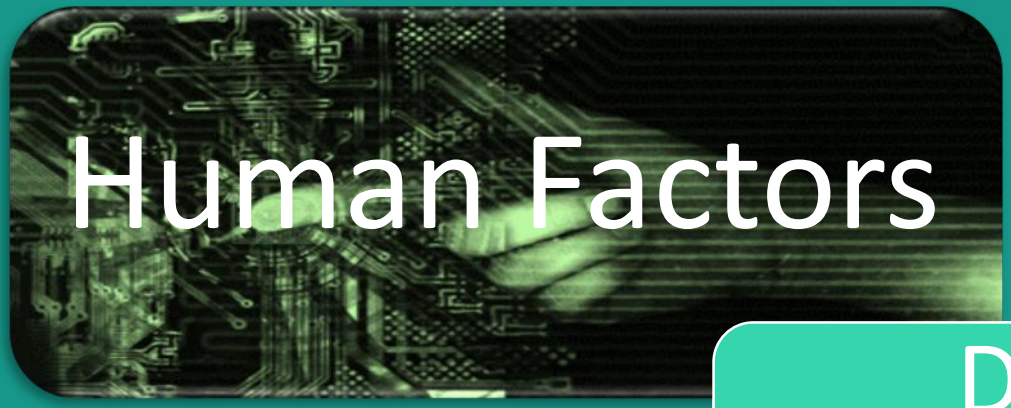


Smart Mobility



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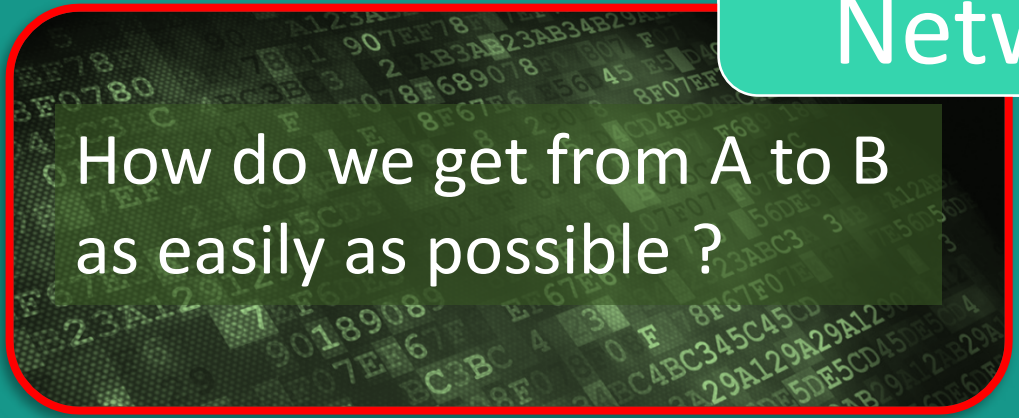

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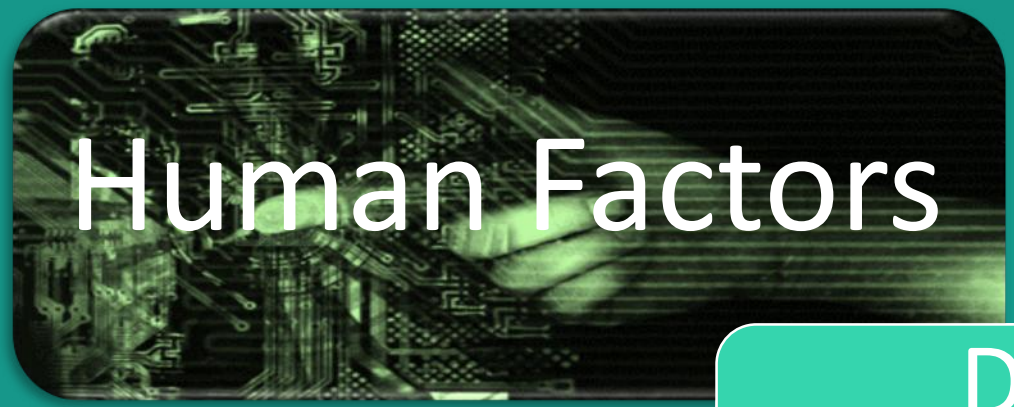

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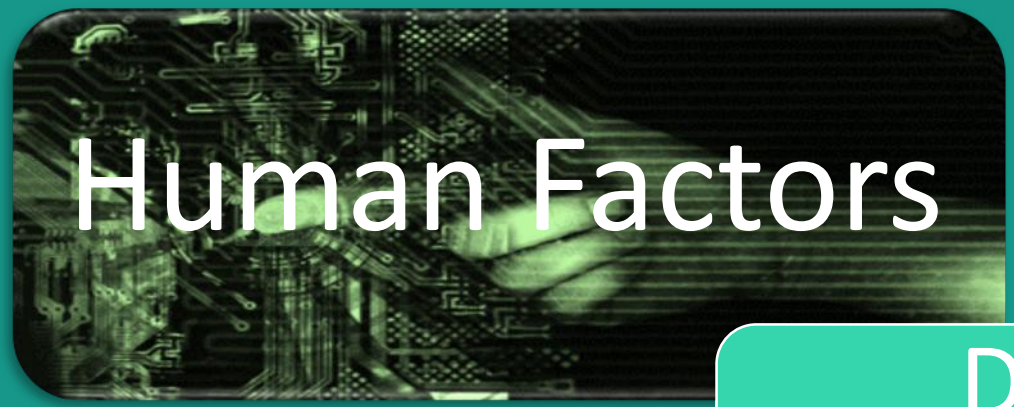

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