

Inductive Power Transfer: A New Transportation Technology

16-17 March 2016,

Wellington NZ

Presented by:

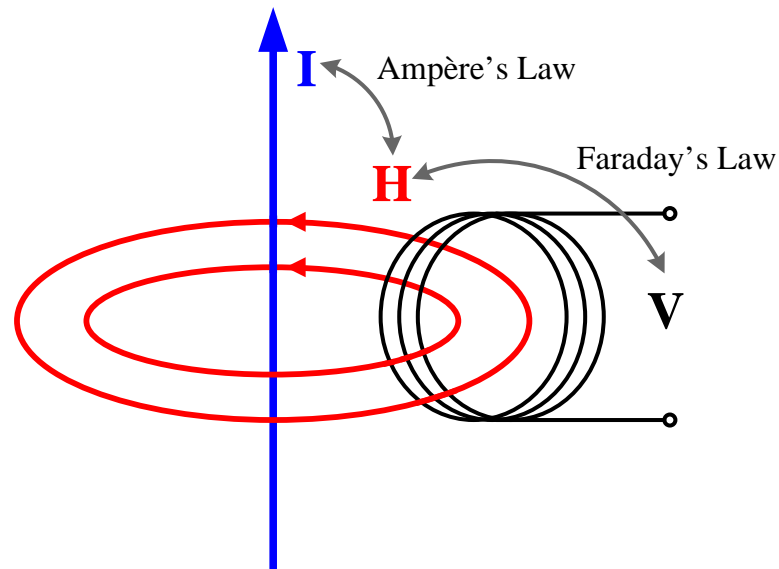
Dist. Prof. Emeritus John Boys

Professors G. A. Covic and J.T. Boys
Inductive Power Research Group
Department of Electrical and Computer Engineering
The University of Auckland, New Zealand

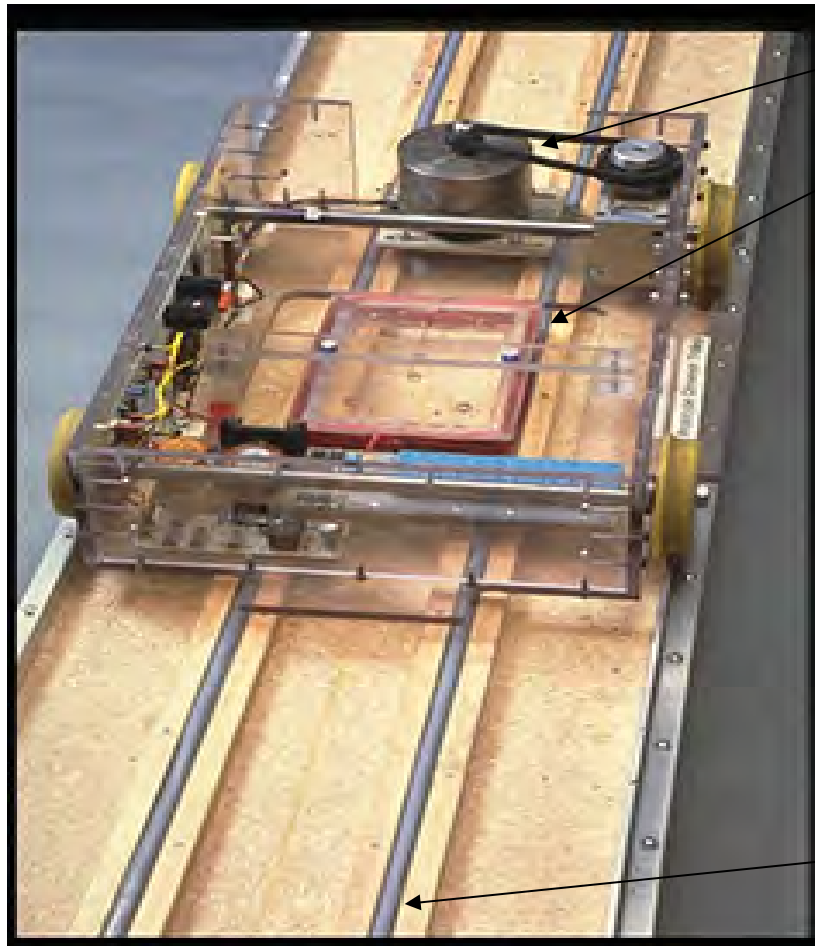


Inductive Power Transfer (IPT)

- The transfer of electrical power from one system to another, without wires.
- Reliable
- Tolerant of water, chemicals, and dirt.
 - But regarded as impossible for 200 years



1990: A first WPT System at the UoA.



Brushless DC Driving Motor

2mm Operating air-gap

- Alignment non critical
 - No power regulation
 - Maximum 1 trolley/track
 - Large pick-up coil
 - Low efficiency
- But it worked!!!

100 pair telephone cables

A Sceptical Background: 1

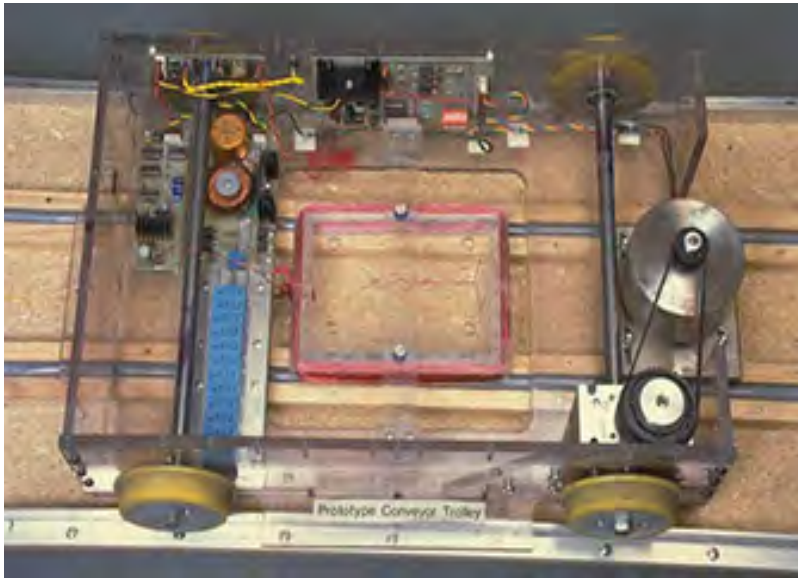
- “Inductive Power Transfer cannot be done”
(Jervis Webb):
 - Signals: Yes
 - Tooth-brushes: Yes
 - Real Power: No!
- Our background made it possible
 - power electronics,
 - resonant circuits,
 - electromagnetics

Daifuku wanted

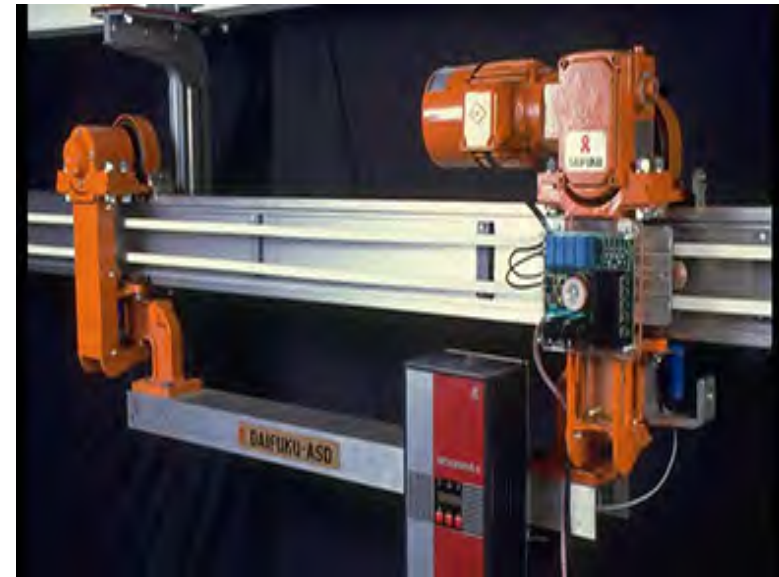


- Power rating/secondary > 200 Watts each, all independent
- System Efficiency > 75%
- Delivery < 4 Months
- Special terms Payment on completion
Assistance with components

Prototype Comparison



Original System



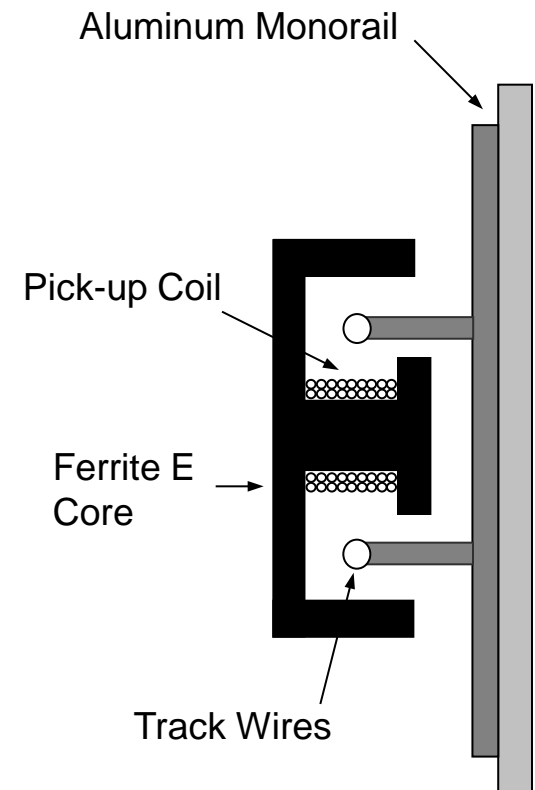
Daifuku Prototype

Power rating	1W	400 W
Efficiency	<10%	85%
# of Carriers	1	3
Load	75 kg	250 kg
Speed	0.1 m/s	1 m/s
Track current	80A	80A
Track length	3 m	25 m
Air-gap	2 mm	4 mm

Prototype Operation



- Allowed movement
- Tolerant of misalignment.
- Unaffected by the environment

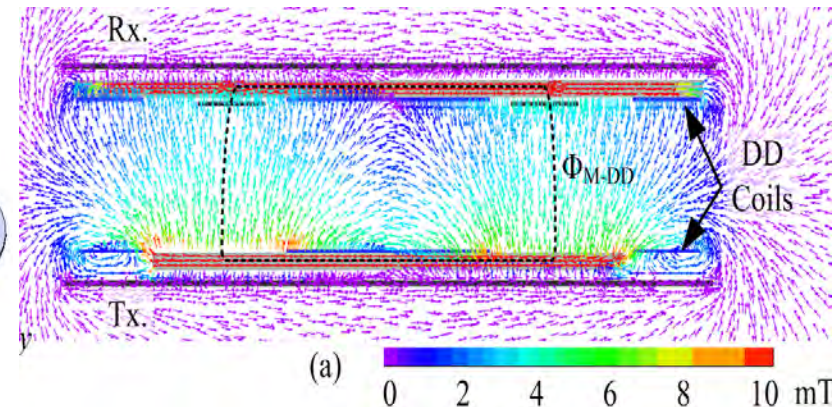
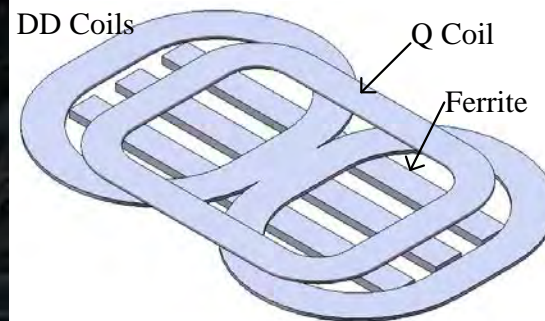


Sceptical Background: 2

- “Even if power could be transferred control would be impossible”
 - Invented a new controller that allowed multiple independent vehicles on one supply
 - Filed 60+ patents, all licenced globally

Sceptical Background: 3

- “Magnetic fields at VLF frequencies are difficult to manage or unsafe”
 - Developed field shaping methods operable over a wide frequency range
 - Our systems are low leakage and highly efficient



Sceptical Background: 4

- Industry will never pick this up
 - “It is too risky to have any real chance of success”
(MoRST – now MBIE)
 - Daifuku took up a licence in 1994 and sold systems within 12 months
 - Are the market leader in clean factory automation



Expanding the License base

- (1997-2010)
 - Conductix-Wampfler: Materials Handling and Buses
 - 3I Innovation: Lighting
 - Cabco: Charging Kid Karts
 - Tracam: Security systems
 - Lantel: Flying carpets



Developing Long Term Relationships

- Required for successful technology transfer
 - Industry driven R&D they can sell
 - Up-front fee + licence royalty agreement + priority research
- On-going IP creation
 - Enables market protection
- Optimistic can do attitude
 - Listen to customer wants (even if think crazy & doesn't use your original idea)



Sceptical Background: 5

- “Despite industrial successes commercial EV systems are too difficult”
 - EV wireless charging is now a preferred option
 - Dynamic powering is under development
- HaloIPT formed over 3 years
 - Sold and relicensed after 1.5 years to Qualcomm
 - Large R&D funding secured for roadway power developments



Case Study: Forming HaloIPT

- 2007
 - Noted shift in market
 - Improved our magnetic designs
 - Floated concept (“kissing frogs”)
 - Engaged licensees unsuccessfully
 - Engaged OEMS at EVS23 with support of Uniservices
- 2008
 - On going discussion with licensees
 - VOM (November)
 - Improved gap & tolerance, power
 - Low cost and low weight
 - Capable of one to many
 - Secured pre-seed accelerator funding
 - Requested Nov 08

IPT Wireless Charging System



- 2009
 - Defined our vision & difference
 - EVS24 showcase (funded by pre-seed)
 - Took on additional funded projects
 - Engaged with potential seed investors and funders

Vehicle
controller



Charger: 2kW single phase supply

220mm airgap

Defined the vision



IPT street

Conductive charge street

Safe and Durable

Easy to use

Aesthetically pleasing



HalolPT: Launched May 2010



Affixed vehicle pad &
Transmitter pad

- April - Seed funding with Arup & TTF
- June - Delivered showcase system to Tier 1 (300 mm)
- Oct - London Launch
- Nov - EVS25 Showcase

Ongoing OEM Trials



HalolPT: Sold October 2011



Rolls Royce Phantom 102Ex

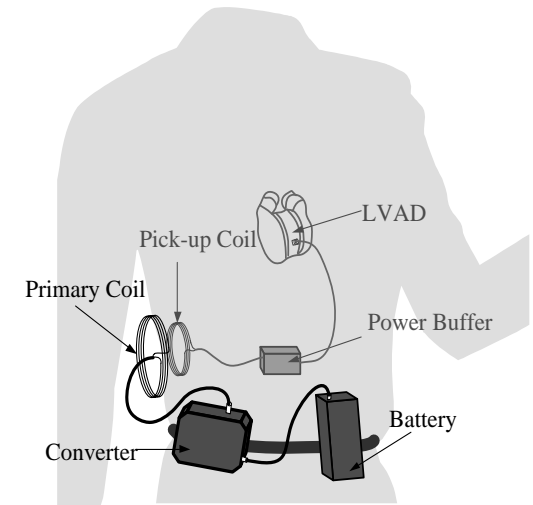
7kW charge system > 90% Efficiency



- March
 - Phantom experimental EV
 - Wins Clean Equity Monaco Award
 - “Excellence in the field of environmental technology research”
- May
 - Partnership formed with Chargemaster
- June
 - Series A investment sought ... offered sale, but with on-going relationship!
- July
 - Partnership formed with Drayson Racing for formula1-E race cars
- Sept
 - Shortlisted for Green fleet industry innovation award (London)
 - Wins 2 NZ innovation awards (“Emerging Innovator” & “Design & Engineering”)
- Oct
 - Sale completed and research licence relationship defined
- Nov
 - Qualcomm announce 40-50 car trial in UK

Other Start up Companies

- Telemetry bought by Millar research
 - Heart pumps
 - Biomedical sensors
- Power by Proxi
 - Home applications
 - Inductive Slip-rings

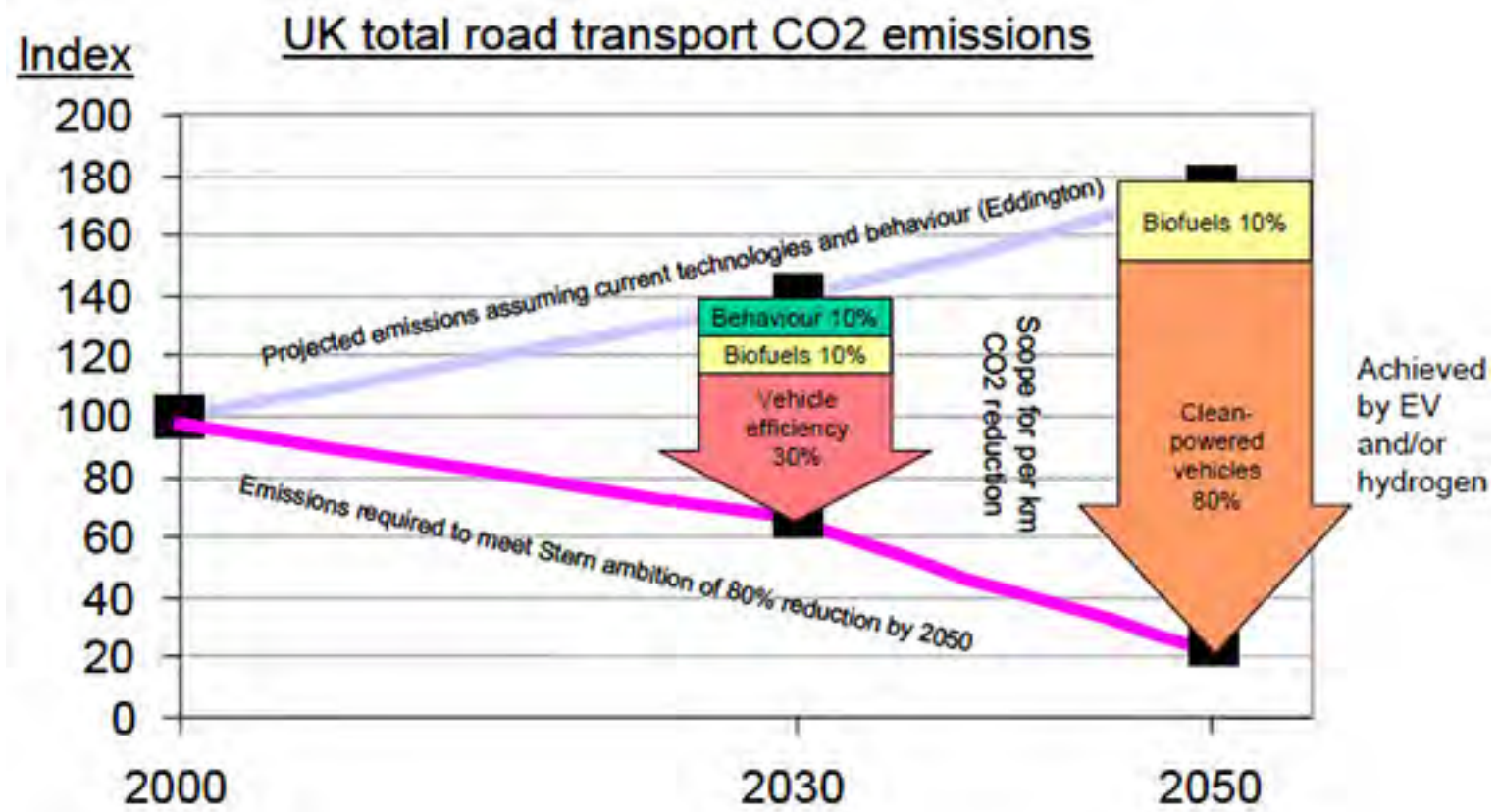


A Future Vision



King Review:

The Future is shaped by low carbon vehicle technologies
Must have increased electrification of vehicles



New generation required for growth

Some more 'low carbon' than others



Nuclear



Coal



Hydro/storage



Gas CCGT



Onshore Wind



Biomass



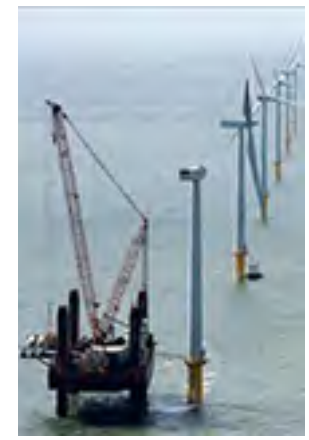
Wave



Tidal Stream/Barrage



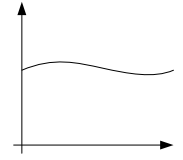
Solar/CSP



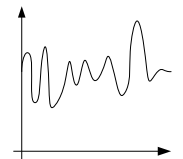
Offshore Wind

Battery charging with dynamic demand control (DDC)

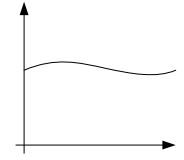
Conventional Generators



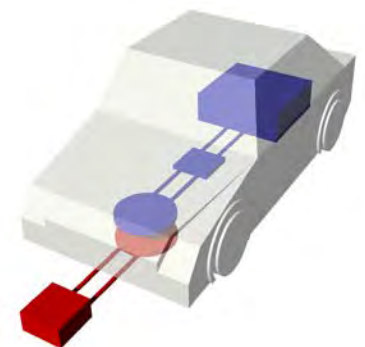
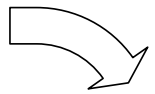
Wind Farms



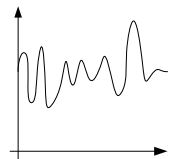
Electricity Grid
Constant Frequency &
Constant Voltage



Conventional Consumer

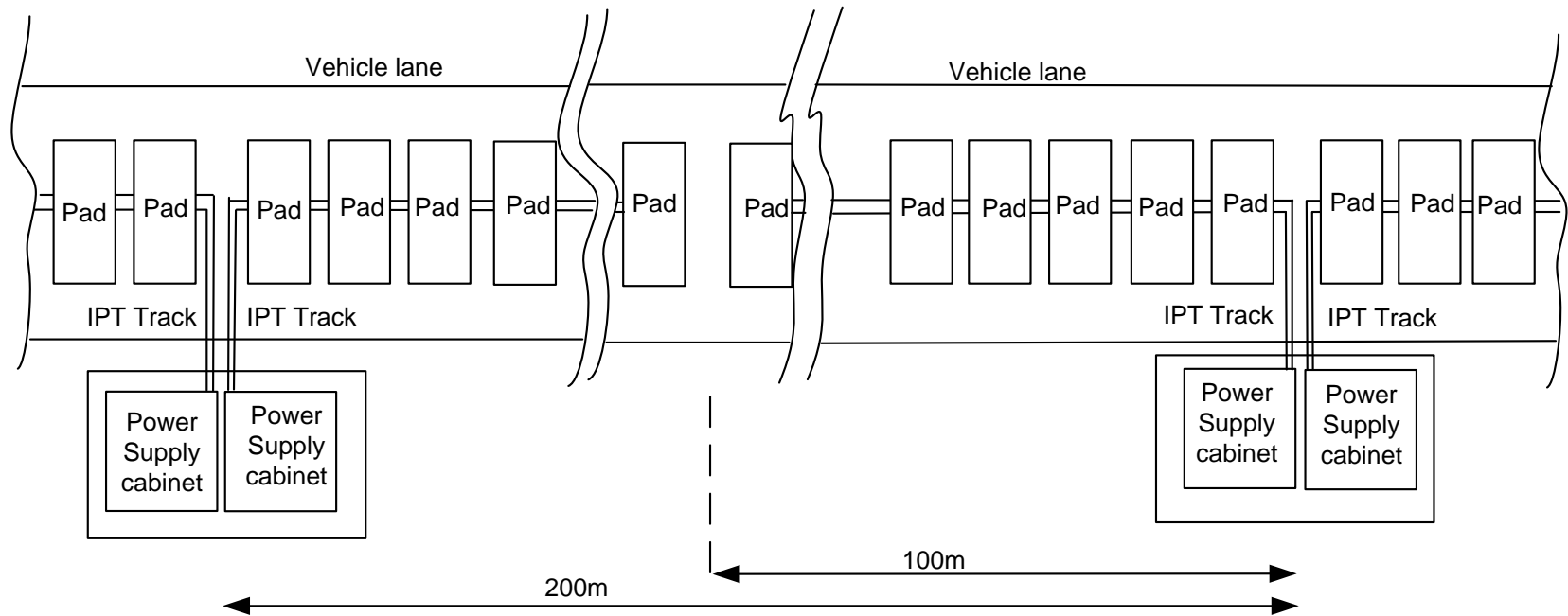


DDC Electric Vehicle Chargers

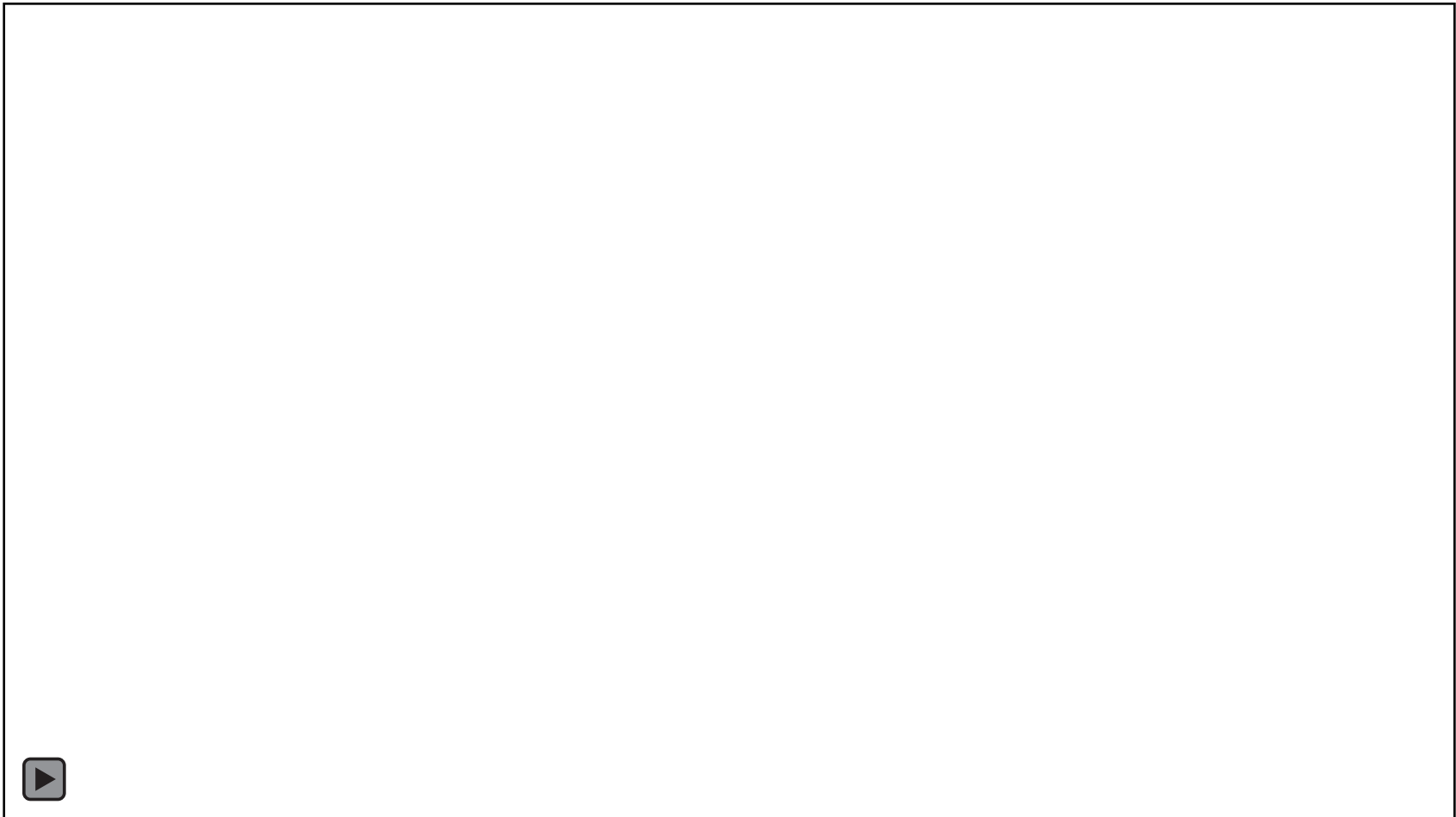


The IPT Roadway

- Sequentially Energised Pads under the Vehicle



The IPT Roadway



Dynamic charging allows lower battery weight. Requires gaps 20-40cm

Why have we been successful?

- Partnerships with licensees
 - 7 global licensees and 3 start-up companies
 - Our postgrads now work in these key industries
- Industry driven research
- Funding for blue-sky innovation
 - Imagining the future
 - Attracting the best students
- The world leaders in industrial IPT systems
 - Academically and through our commercial partners