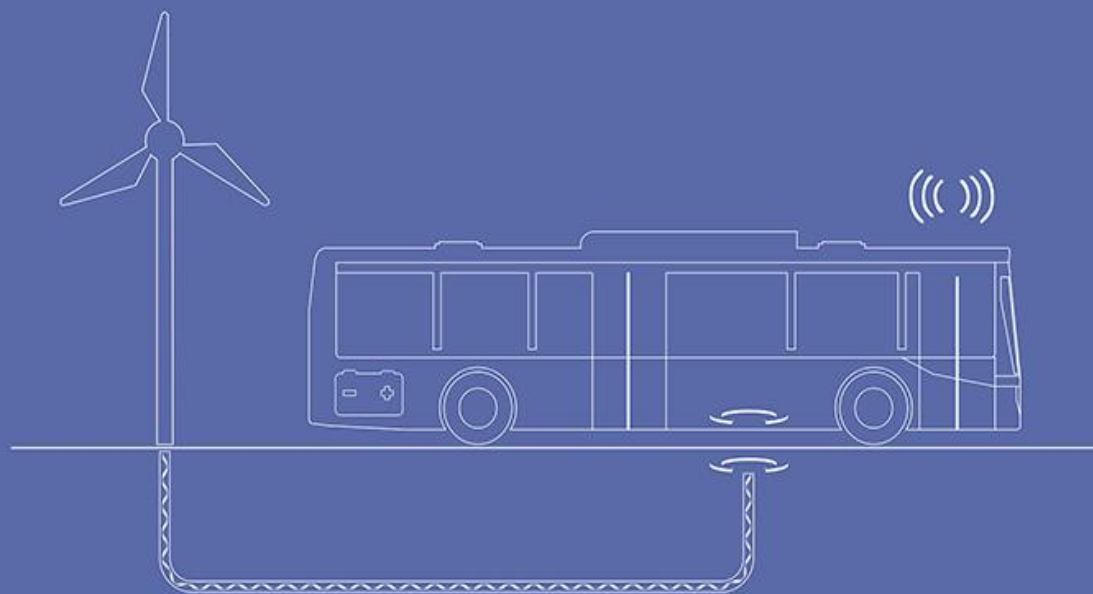


proov

unplugged e-mobility



NO catenary – NO problem



PROOV'S VISION:

: “The healthy way to zero emission urban transport”

Urbanisation

70%

in 2050

Trends:

Zero Emission

Easy use

Reliable

Wireless

Lowest TCO

Local Power Generation

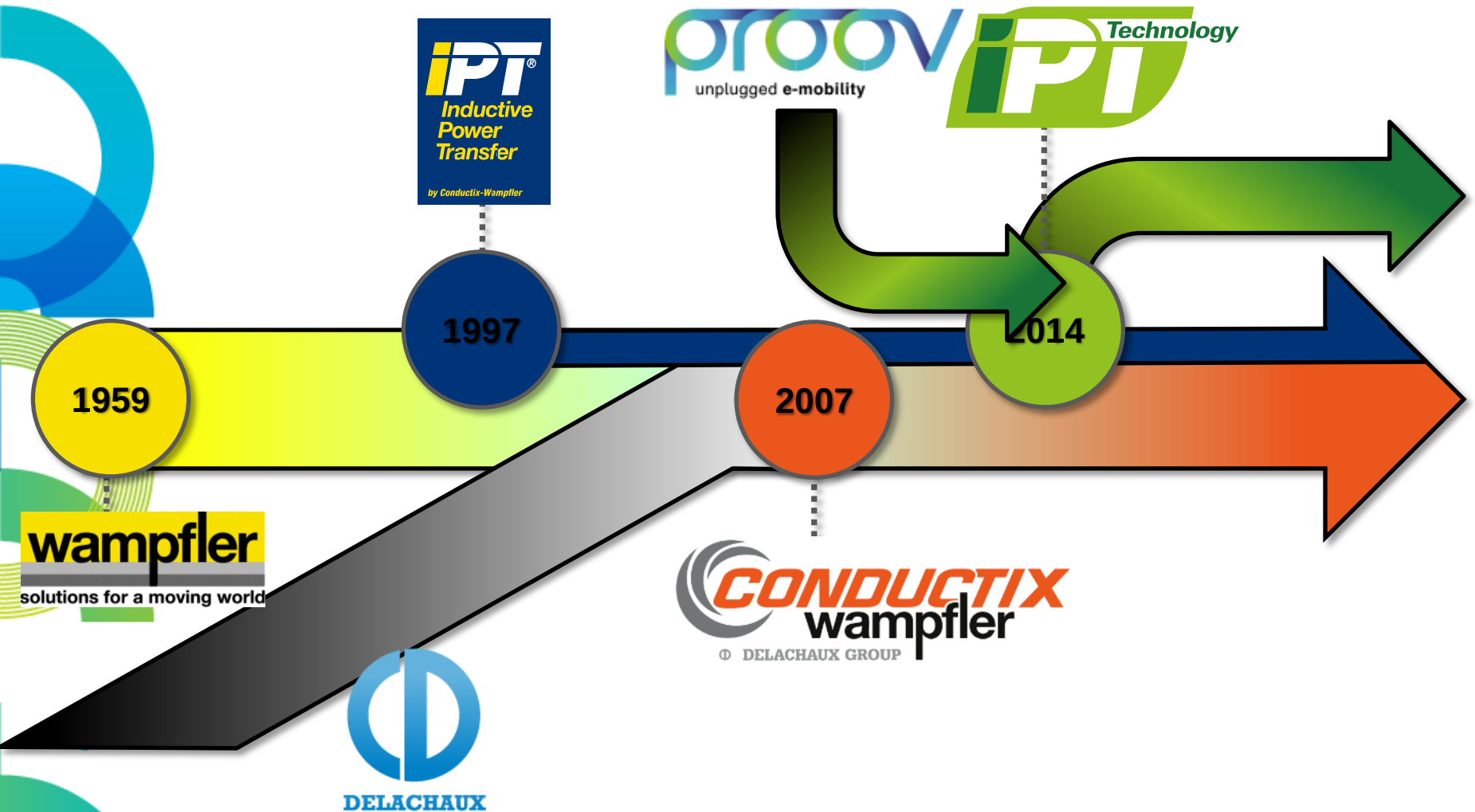
OUR MISSION

- **PREFERRED PARTNER** FOR UNPLUGGED E-MOBILITY
- OFFER THE **BEST TECHNOLOGY**, ARE THE SPECIALIST TO PROVIDE **TOTAL SYSTEM SOLUTIONS** WITH ADDED VALUE CUSTOMER SERVICES
- COMBINE **GLOBAL APPROACH** WITH HIGH QUALITY **LOCAL COOPERATION PARTNERS**

History and organisation



History



Markets



Markets



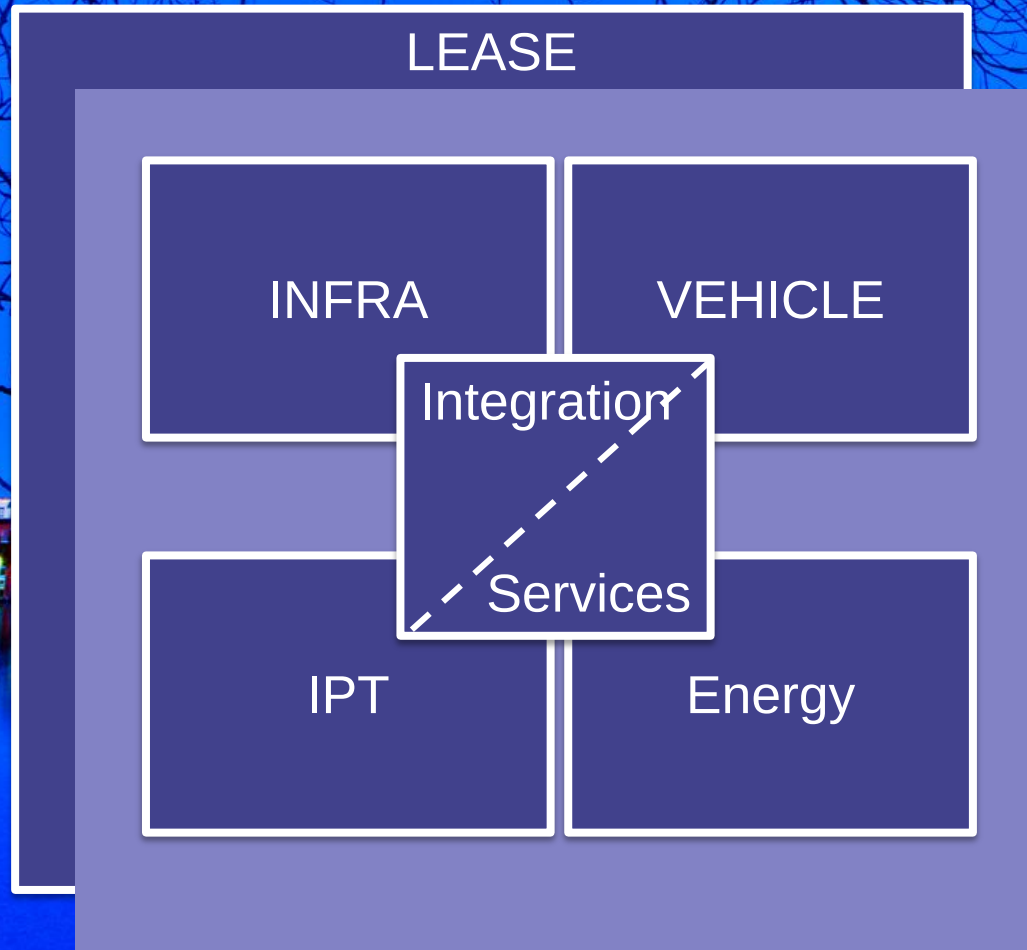
2014



Global approach - Local cooperation



TOTAL SYSTEM APPROACH



Location



IPT Technology GmbH

Im Martelacker 14 | 79588 Efringen-Kirchen | Germany

Core competences



Design

Production

Implementation

Services

Research

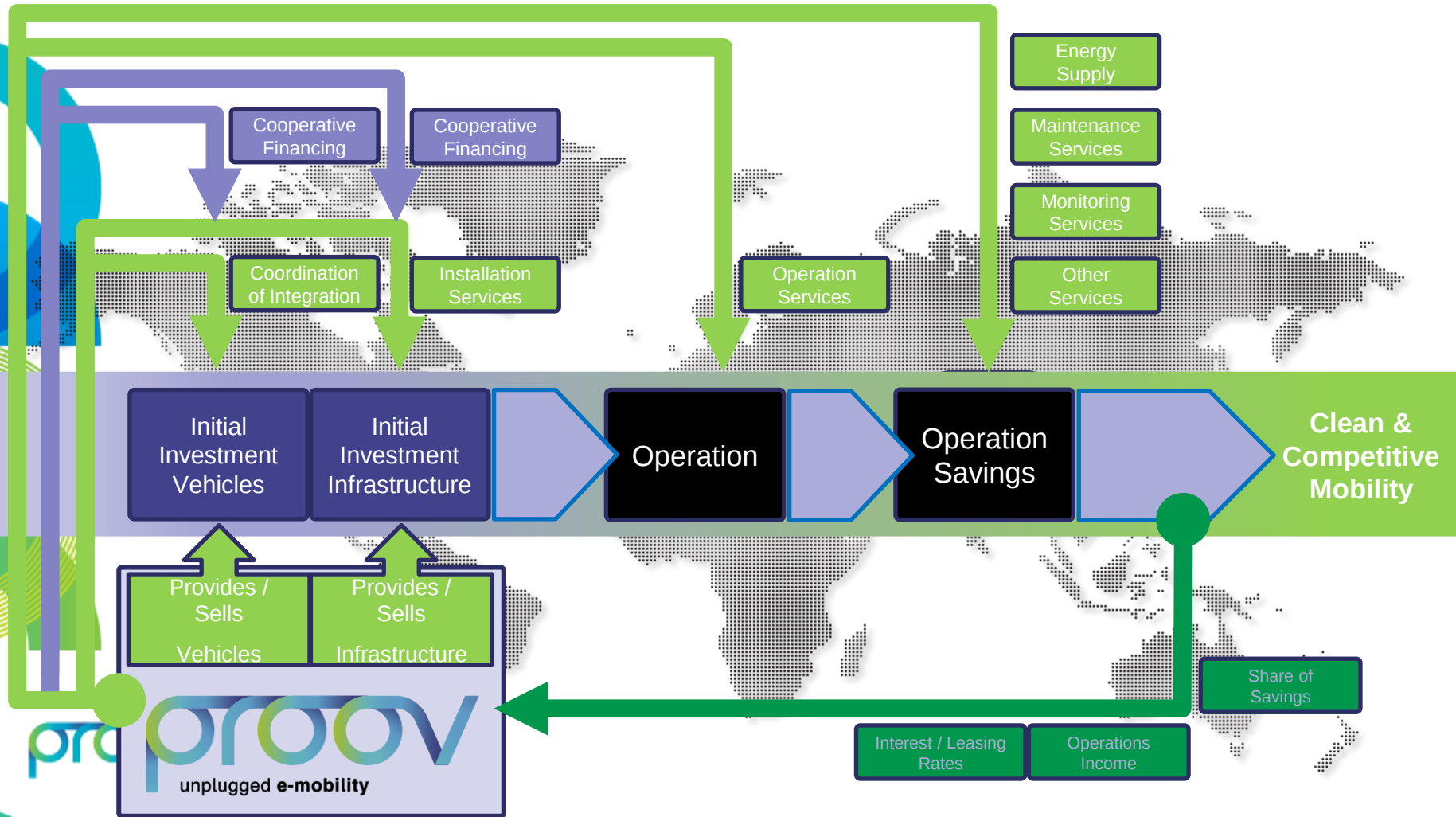
Customizing

System
Engineering

Monitoring

proov

PROOV | Scopes & Services



CLEAN & COMPETITIVE & SUSTAINABLE BUSINESS CASE



Responsible Reliable E-Mobility Operation



Clean
Quite
Safe operation
Protection of resources

Electric Drive Systems

Ecologic & Economic Win-Win with IPT® Charge

No plugs, less batteries
No emission fees
No worries, efficient
Cost competitive

CO₂e/TCO (Eur/km) Comparison

NOTE: RANGE ALSO SHOWS EFFECT OF ALTERNATIVE PRODUCTION SCENARIOS

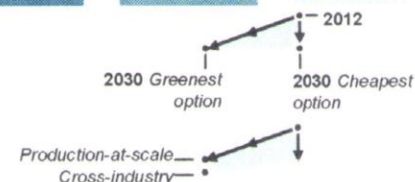
WELL-TO-WHEEL

12-M BUS

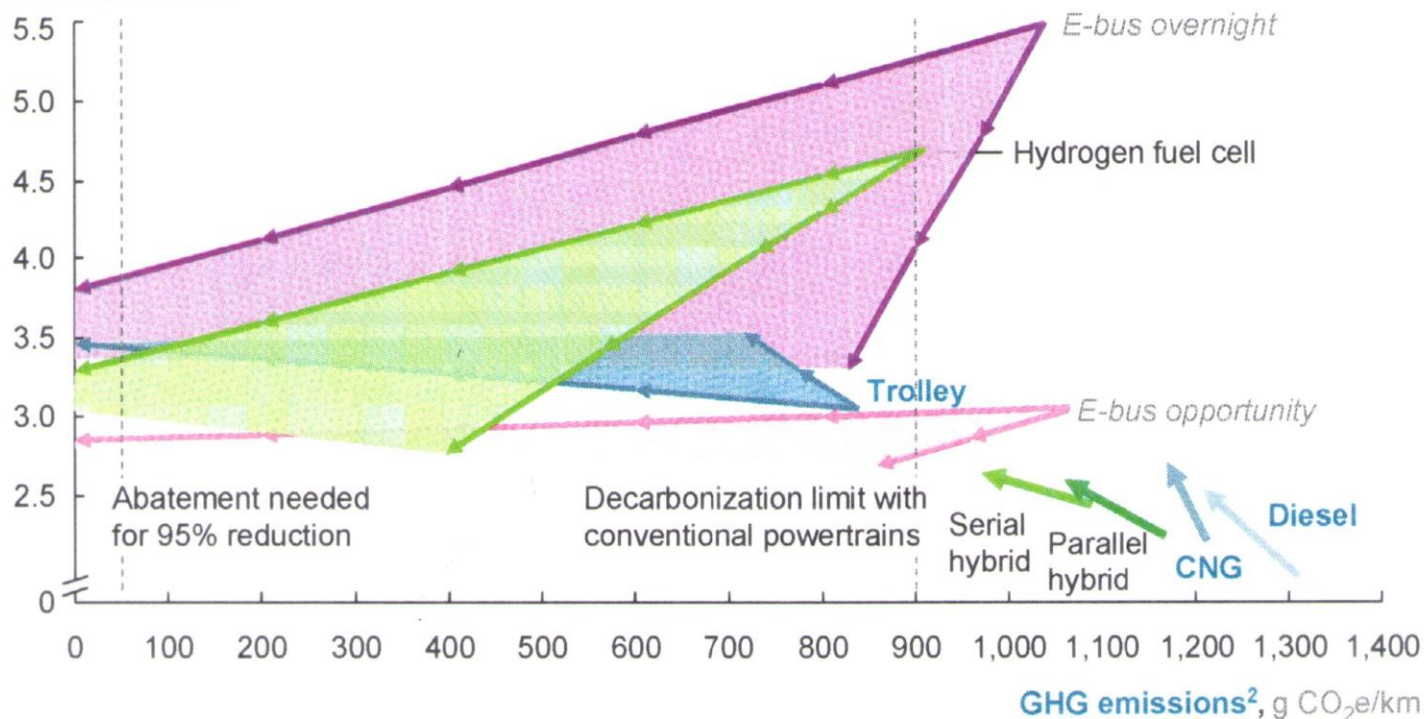
2012-30

Labelling of powertrain according degrees of operational experience (km driven)

- Commercial solution (>>100 million km): conventional, trolley
- Test fleets (>1 million km): diesel hybrids, fuel cell
- Prototype phase (<10,000 km): e-buses

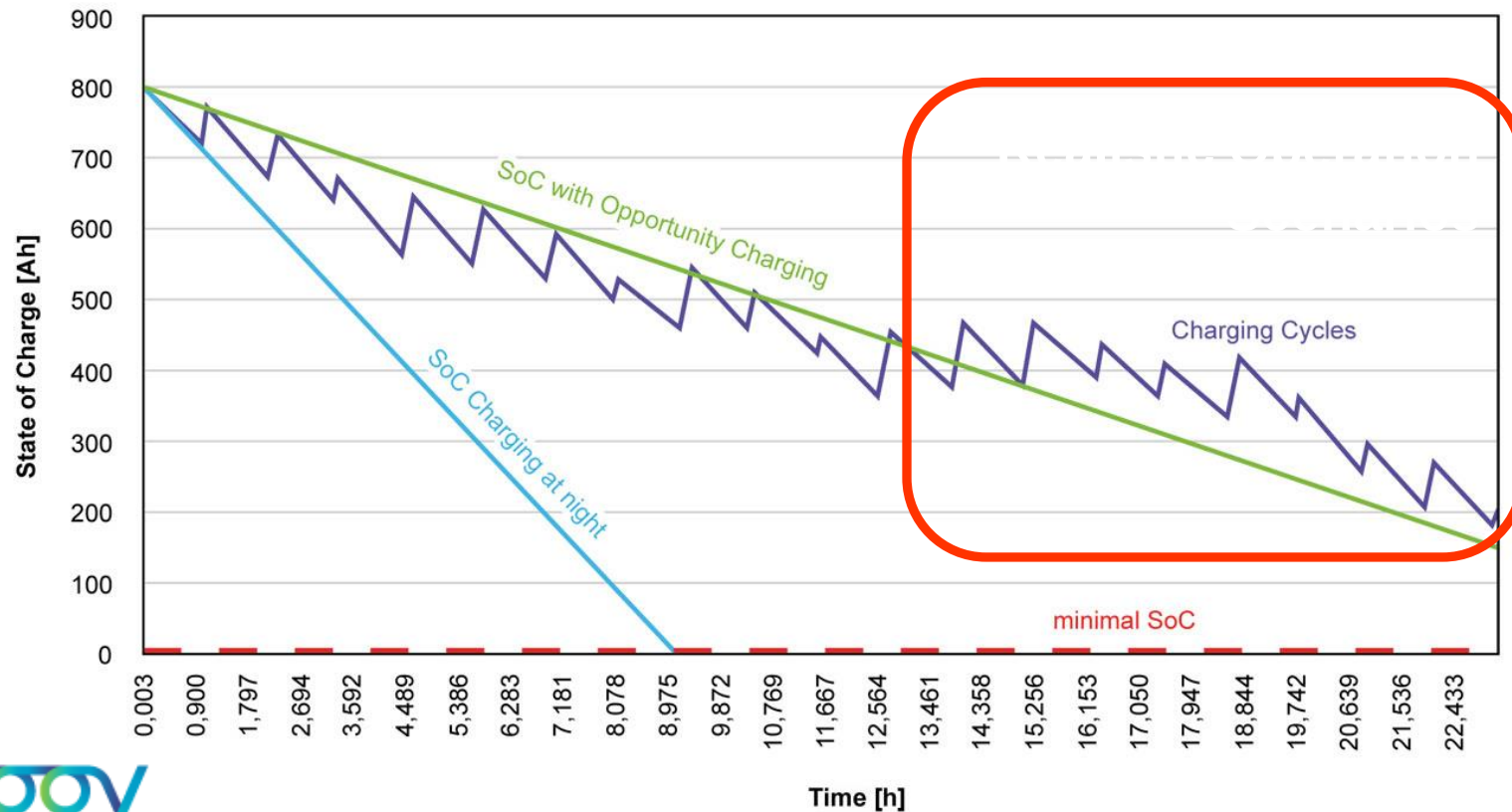


TCO^{1,3}, EUR/km

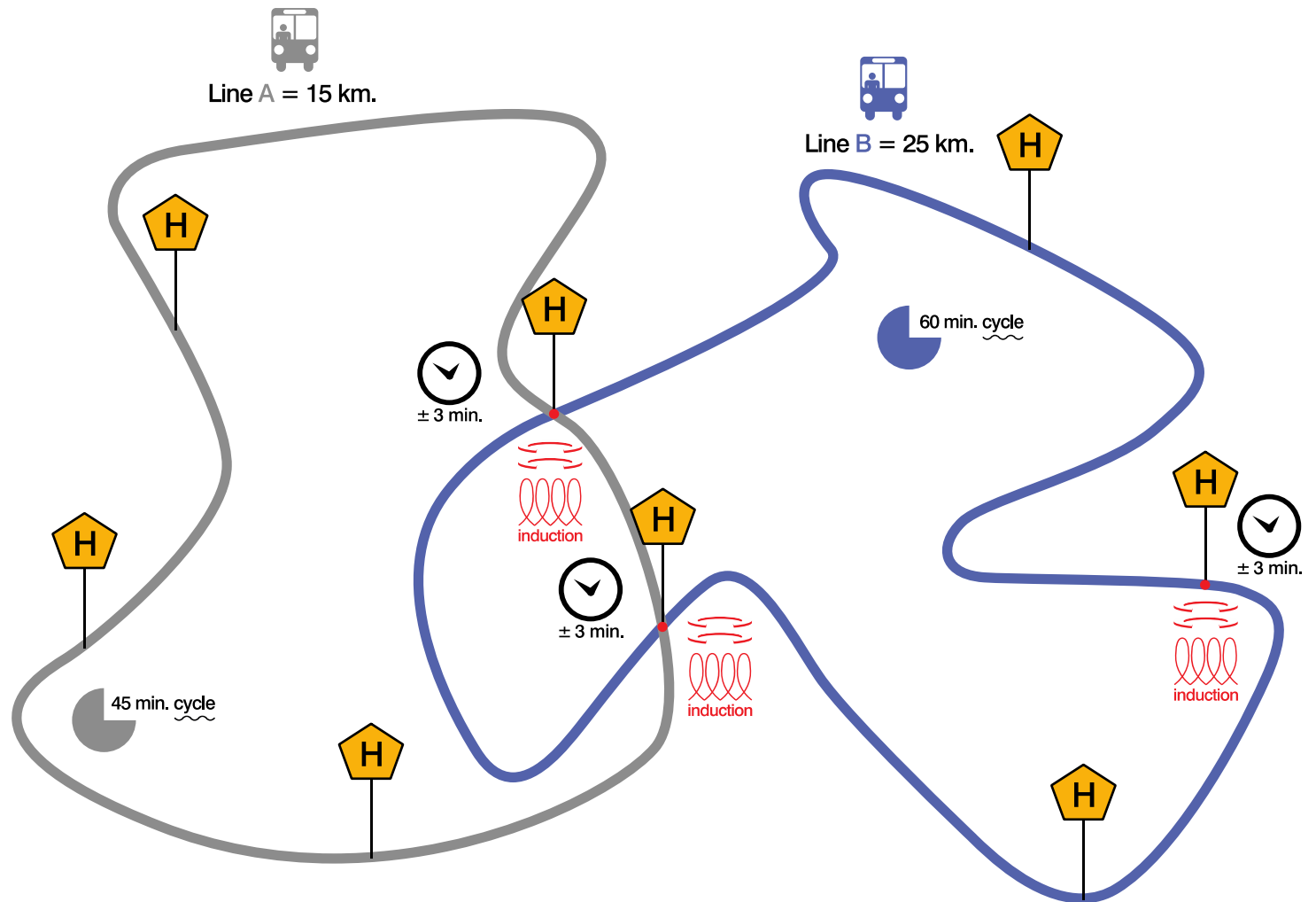


Opportunity Charging with IPT®

Longer operating times for electric Busses with Opportunity Charging



SMART LOGISTICS & FINANCIAL GRID ENGINEERING



Applications



Responsible Reliable E-Mobility Operation



Clean
Quite
Safe operation
Protection of resources

Electric Drive Systems

Ecologic & Economic Win-Win with IPT® Charge

No plugs, less batteries
No emission fees
No worries, efficient
Cost competitive

CLEAN, CONVENIENT AND COMPETITIVE URBAN TRANSPORT

CHARGED BY IPT TECHNOLOGY, POWERED BY PROOV



Over 8000 buses in London

1st ORDER LONDON SEPT 2014

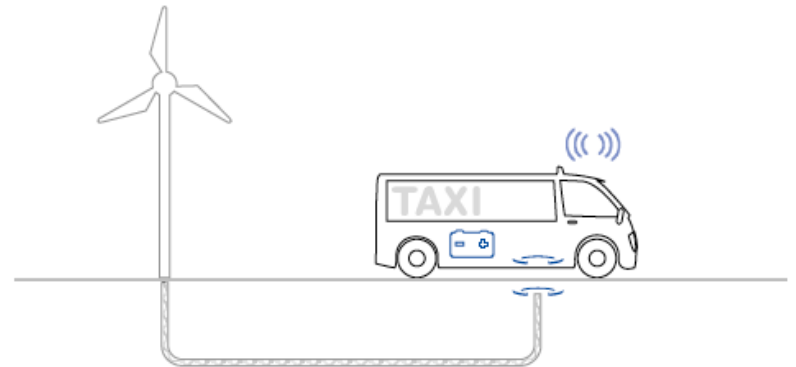
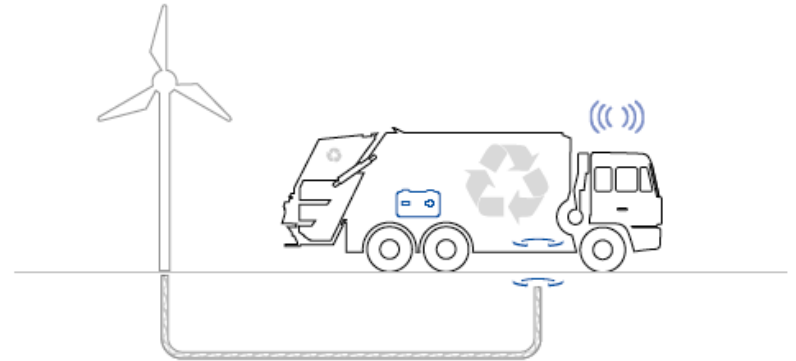
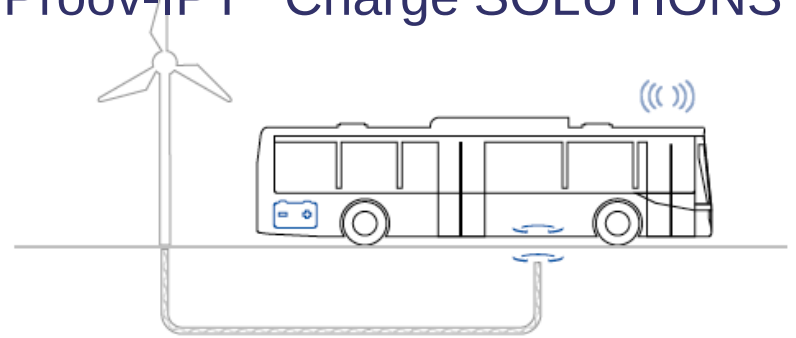
1000 IPT INDUSTRY REFERENCES
IN CRITICAL PRODUCTION PROCESSES IN INDUSTRY
AND MATERIAL HANDLING





proov
unplugged e-mobility

Proov-IPT® Charge SOLUTIONS



**3 IN ONE:
POWER-STORAGE-TRANSFER**

Unplugged E-Mobility Operation



Over 50 buses in operation including Utrecht, London, Glasgow, ...

Genoa, Italy | since 2002

Type of vehicles / Manufacturer:

Electric buses 120 kW Motor / EcoPower Technology s.r.l.

Energy storage:

Lead-Gel battery 180 A

Vehicle weight: Empty approx. 7,5 t / Max. approx. 10,2 t

Charging power per load point: 60 kW

Number of vehicles: 8



Turin, Italy | since 2003

Type of vehicles / Manufacturer:

Electric buses 120 kW Motor / EcoPower Technology s.r.l.

Energy storage:

Lead-Gel battery 180 A

Vehicle weight: Empty approx. 7,5 t / Max. approx. 10,2 t

Charging power per load point: 60 kW

Number of vehicles: 23



Den Bosch, Netherlands | since 2012

Type of vehicles / Manufacturer:

Volvo 7700 (converted to electrical / Bluekens Truck & Bus BV)

Energy storage:

120 kW LiFePo₄ batteries

Vehicle weight: 12,0 t (empty weight)

Charging power per load point: 120 kW (2 modules of 60 kW)

Number of vehicles: 1



Milton Keynes, Great Britain | since 2013

Type of vehicles / Manufacturer:

Electric buses 120 kW / WrightBus

Energy storage:

Lithium batteries

Vehicle weight: 12,0 t (empty weight)

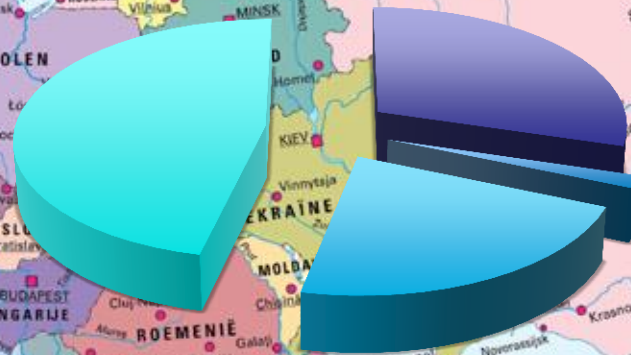
Charging power per load point: 120 kW (2 modules of 60 kW)

Number of vehicles: 8



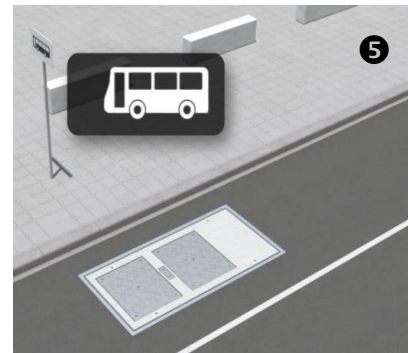
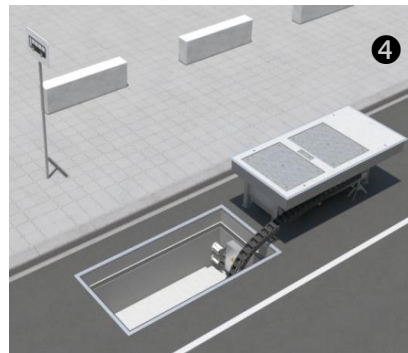
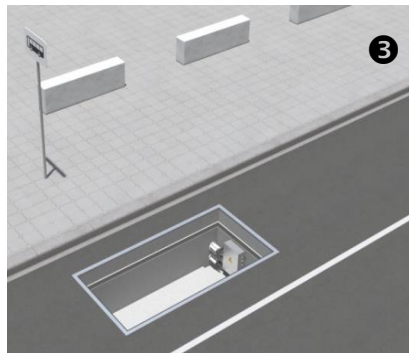
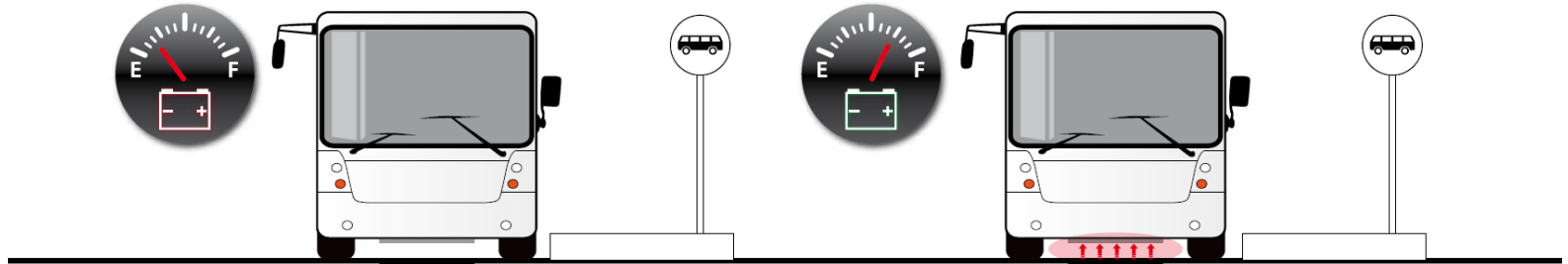
Market share Europe

Number of battery E-Buses in commercial operation 2014



- Proov-IPT
- Bombardier
- BYD
- Small buses

Wireless high power opportunity charging



- ① In-Ground Module installed
- ④ Charge Module connected
- ⑤ Finished Charge Station



- ① Track Supply
- ② Primary Coil
- ③ Secondary Coil
- ④ Rectifier
- ⑤ Battery
- ⑥ Communication System

proov

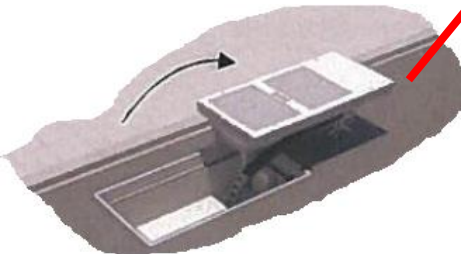
WHAT TO LEARN FROM FIELD OPERATION WITH BATTERY E-BUSES

ENGINEERING, PRODUCTION, IMPLEMENTATION, ENERGY SUPPLY, UPTIME MONITORING, SERVICES

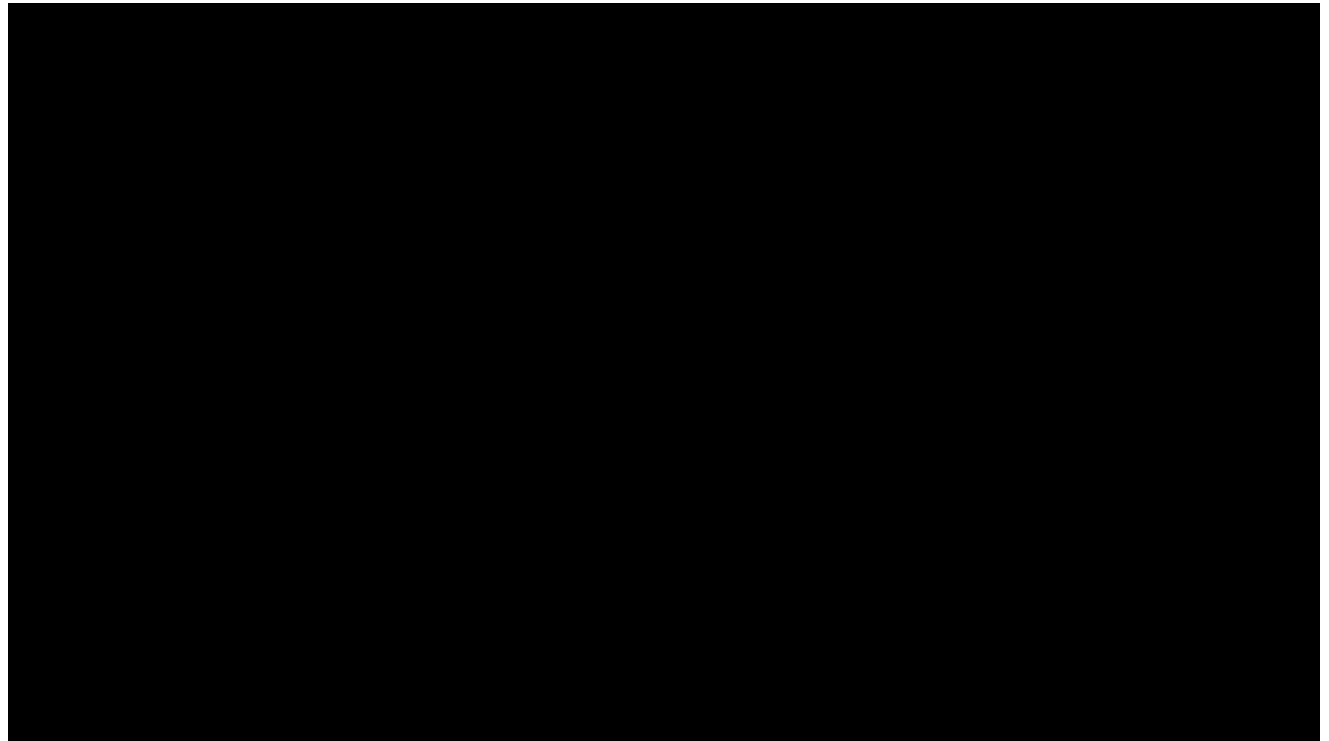


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unplugged e-mobility

Full operational public space project....



Proov Utrecht movie



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2,5 days
operation
In the
public area





Positioning & training of drivers



Importance of monitoring of operation



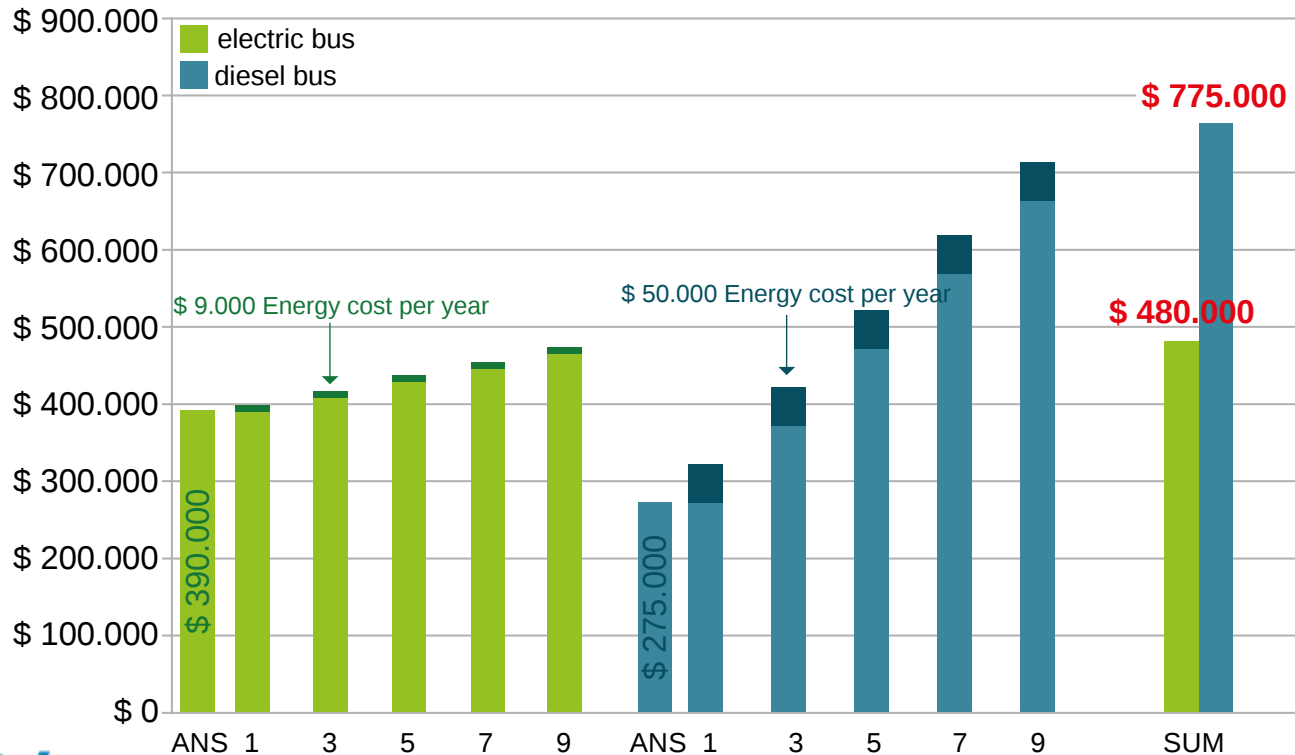
CLEAN & COMPETITIVE & SUSTAINABLE BUSINESS CASE



Cost Saving Operations ... an Economic Boost

Operating cost comparison*: electric vs. diesel propulsion (in US \$)

Acquisition and energy costs, compared over 10 years of operation



* Extrapolation = costs per passenger mile × average annual mileage (50.000 Miles)

1 passenger mile by electric bus = 0.18 US \$, 1 passenger mile by diesel bus = 1.00 US \$,

ANS= Acquisition cost, SUM = Sum total

Sources: Technology Review 2011, Bahninfo.de 2011, Dresdner Verkehrsbetriebe 2011, Optare 2012

Potential Restrictions of Electrification

Range?
Investment?
Restrictions?

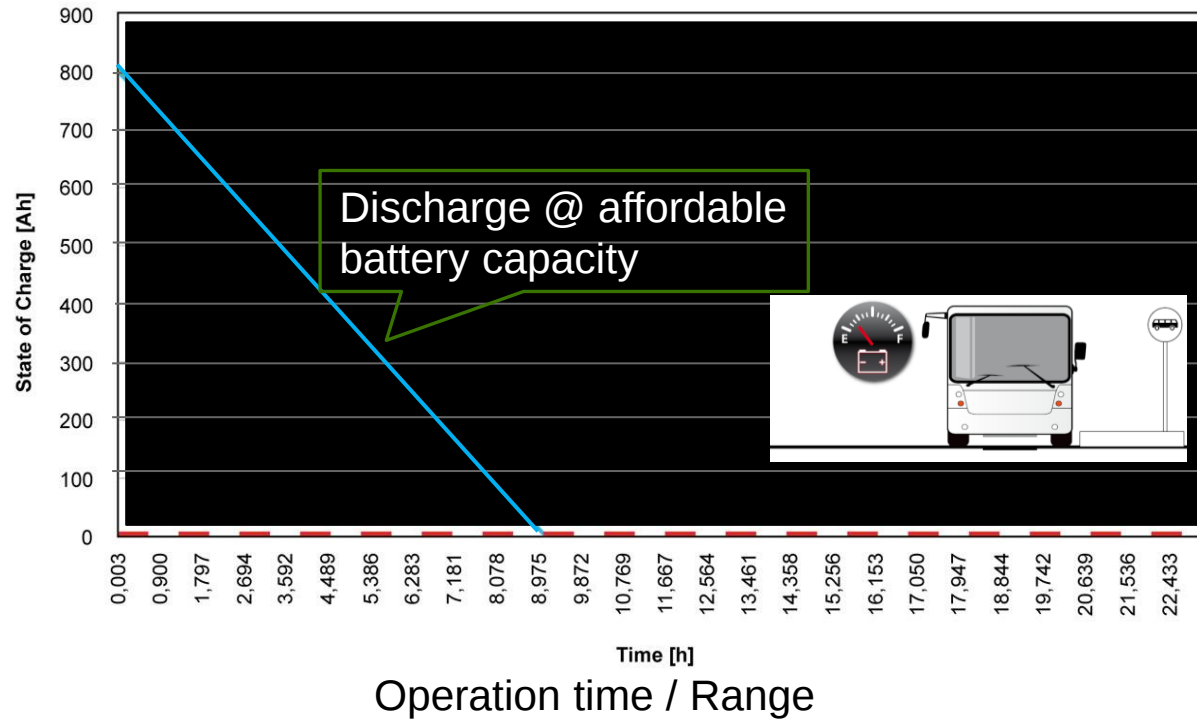
Image Electric Buses:

- More efficient

but ...

- Not enough range
- Too expensive
- Not practicable

Longer operating times for electric Busses with Opportunity Charging



Solution:

Energy storage buses with unlimited range – lowest TCO

Unplugged e-mobility:

Green:

Emission-free and clean energy

Convenient:

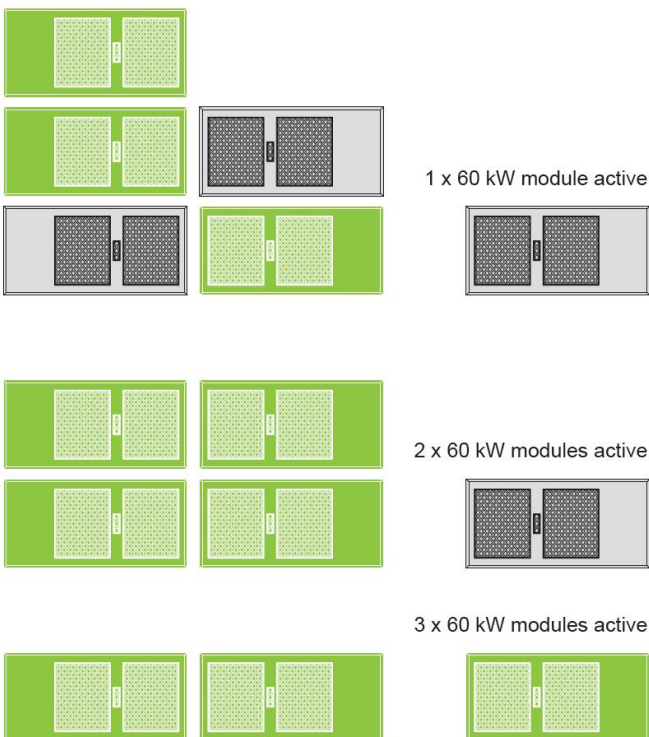
Automated & unlimited range

Economically competitive:

To fuel buses and plug-in Battery buses



Modular Setup Proov-IPT® Charge



Genoa, IT | since 2002

Type of vehicles / Manufacturer:

Electric buses 120 kW Motor / EcoPower Technology s.r.l.
Energy storage: Lead-Gel battery 180 Ah
Vehicle weight: Empty approx. 7,5 t /
 Max. approx. 10,2 t
Charging power per load point: 60 kW
Number of vehicles: 8



Turin, IT | since 2003

Type of vehicles / Manufacturer:

Electric buses 120 kW Motor / EcoPower Technology s.r.l.
Energy storage: Lead-Gel battery 180 Ah
Capacity / Length of vehicle:
 15 seats + 22 stances / 7,5 m
Vehicle weight: Empty approx. 7,5 t /
 Max. approx. 10,2 t
Charging power per load point: 60 kW
Number of vehicles: 23
Daily road performance: Up to 200 km



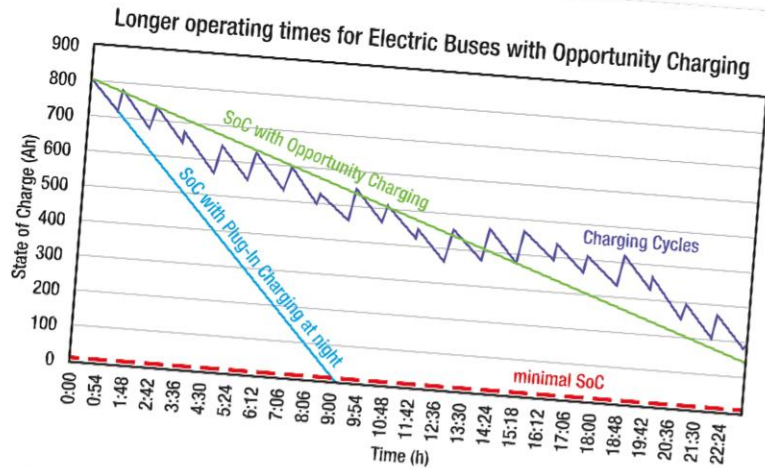
Den Bosch, NL | since 2012

Type of vehicle / Manufacturer:

Volvo 7700 (converted to electrical) / Bluekens Truck & Bus BV
Energy storage:
 120 kWh LiFePO₄ batteries
Vehicle weight: 12,0 t (empty weight)
Charging power per load point:
 120 kWh (2 modules of 60 kW)
Number of vehicles: 1
Daily road performance: Approx. 289 km

Opportunity Charging

Advantages Proov-IPT® Charge SOLUTION SINCE 1997



Opportunity Charging -
The key for cost
competitive operation

- **Less weight**
- **Less cost**
- **Higher capacity**

- Automated, intervention-free charging
- Full integration in urban environments
- Uses available electrical infrastructure
- Unobtrusive
- Makes Zero-Emission realistic today
- **Efficiency**
 - No specific operator skills required
 - Reduced onboard battery capacity
 - Less stress on batteries
 - Increased vehicle efficiency
- **Safety**
 - Safe operation, no plugs to handle
 - Charging widely unaffected by weather conditions
 - Primary coil is buried, preventing any damage from dirt and vandalism



Opportunity Charging with PROOV-IPT®

More than a Decade of Experience – on the Road and off the Road



2002



2010



2014



2012



2005



1998



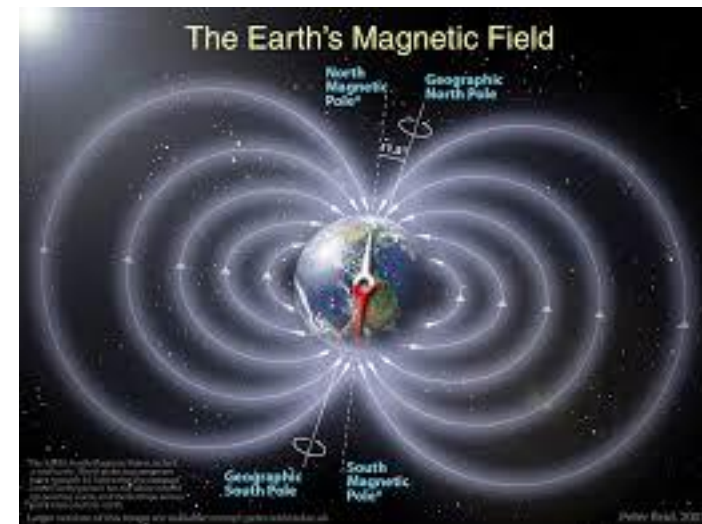
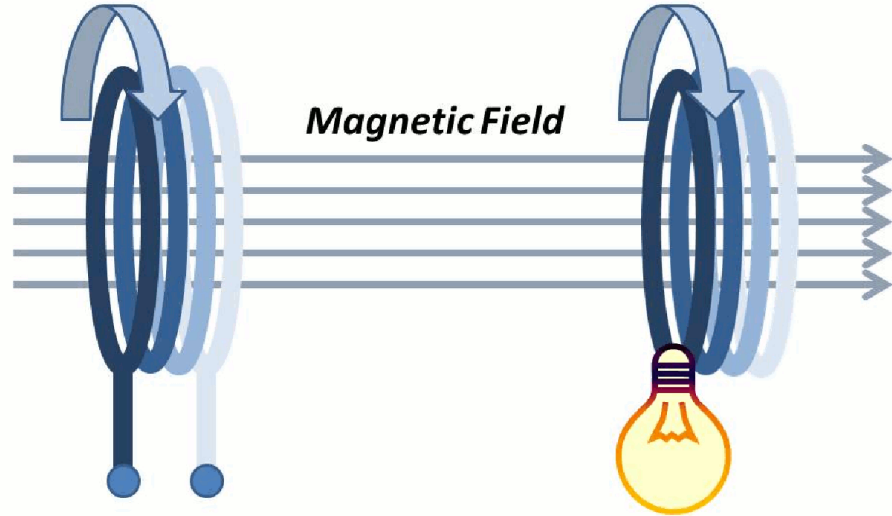
IPT® Charge - not just Turin!

Rotorua, Genoa, Luzern, Japan, Utrecht, Chattanooga UTC, s'Hertogenbosch, Milton Keynes ...



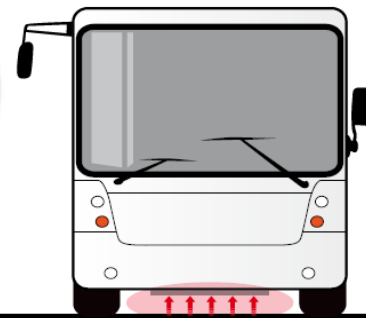
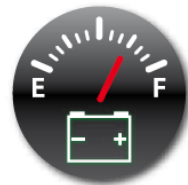
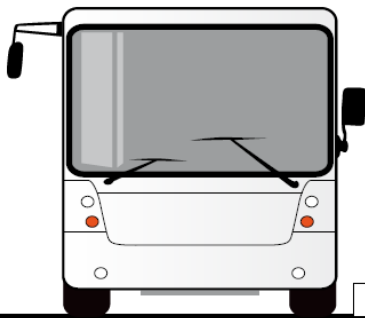
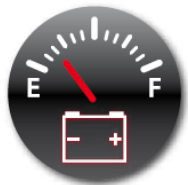
AC Currents

Magnetic Field



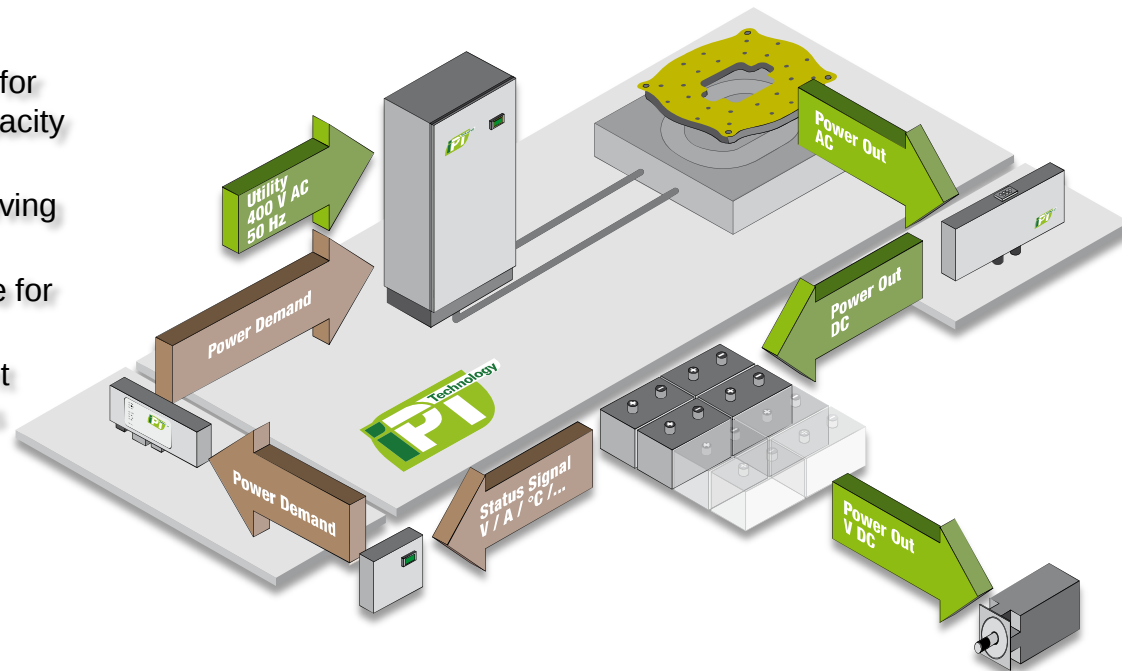
Opportunity Charging with Proov-IPT[®]

- Onboard energy storage is reduced to a minimum to gain a higher payload and/or passenger space. Short but frequent re-charging is required, e.g. at bus stops.
- Even if charging opportunities are less frequent and only possible at large intervals, onboard energy storage capacity can be reduced significantly compared with just overnight plug-in charging.
- This results in a significant reduction of weight and increases vehicle efficiency and payload.
- No worries about cables and plugs to handle.
- Safe and reliable operation even in areas with public access.
- Insensitive to dirt and dust and protected from vandalism.



Ecologic & Economic Win-Win with Proov-IPT®

- Higher vehicle availability, potential for greatly reduced energy storage capacity and so lower operating costs
- Hands-free automated charging serving the future of mobility
- No extra batteries and infrastructure for battery swapping are needed
- Due to smaller batteries, less weight needs to be moved or more room is available to move passengers



Clean

Quite

Safe operation

Protection of resources

Electric

Ecologic & Economic Win-Win with IPT® Charge

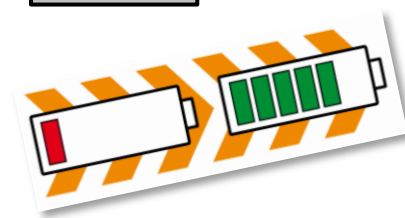
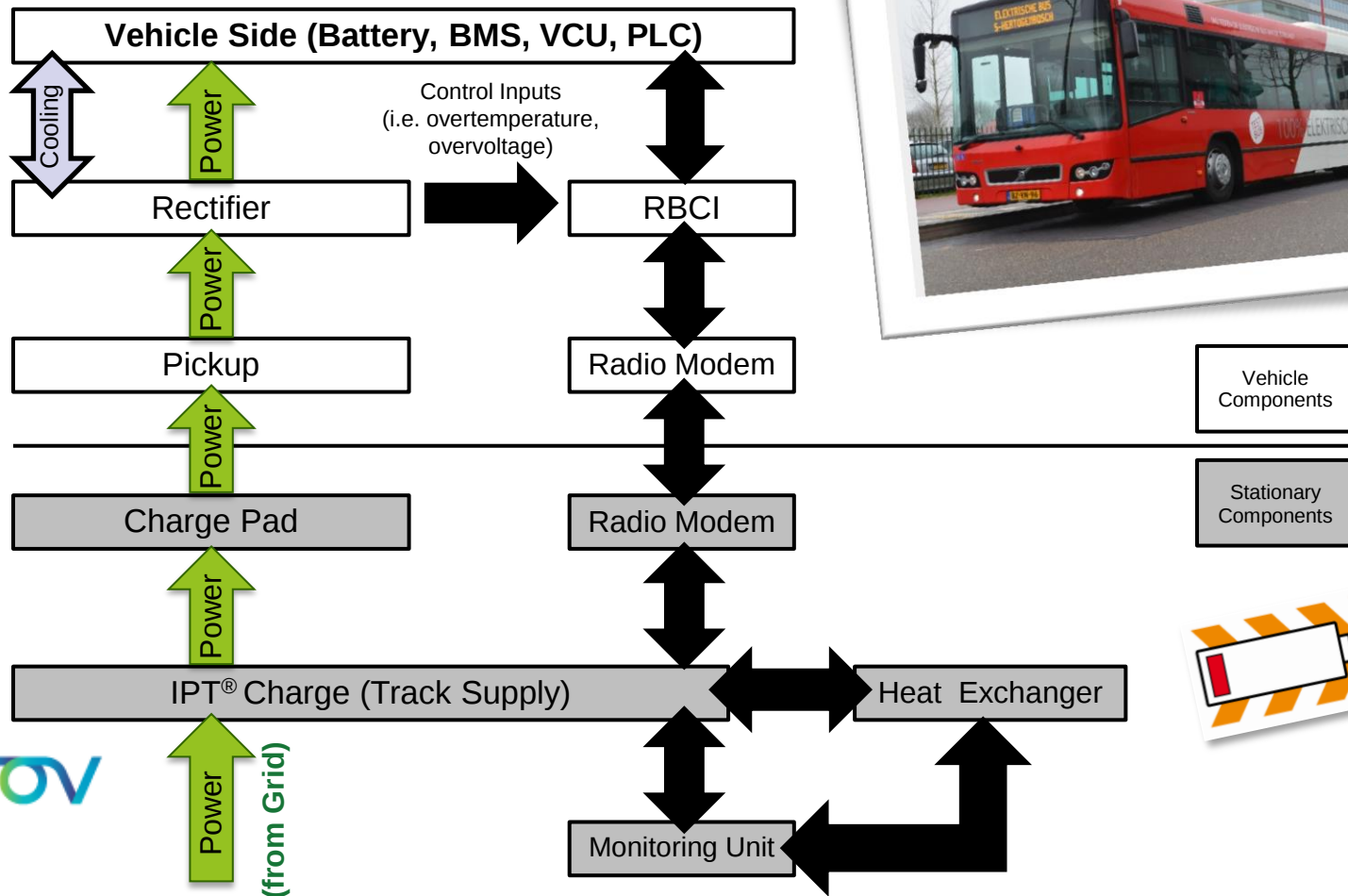
No plugs, less
batteries

No emission fees

No worries

Cost competitive

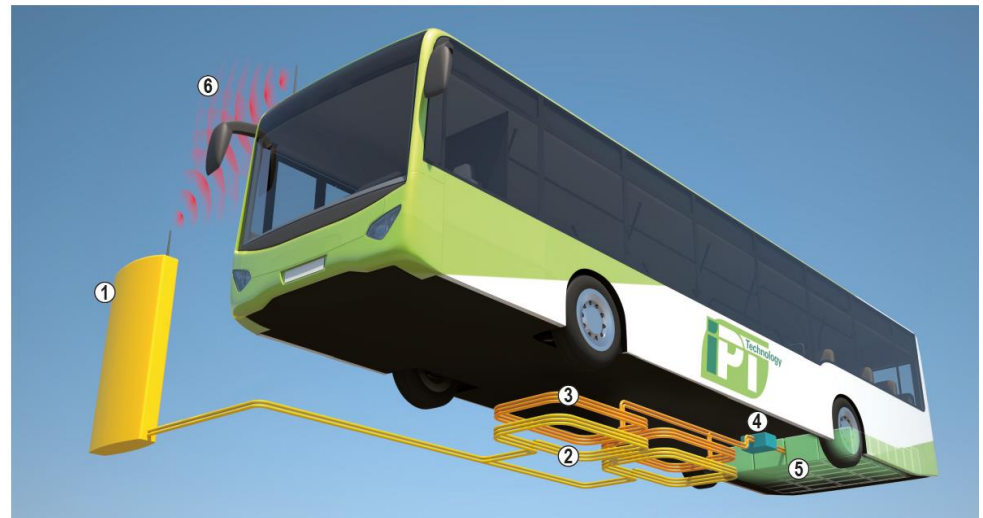
System Overview

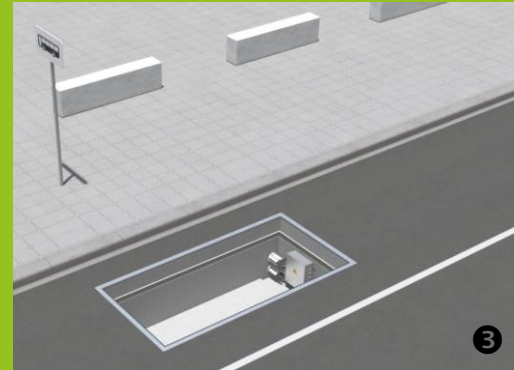
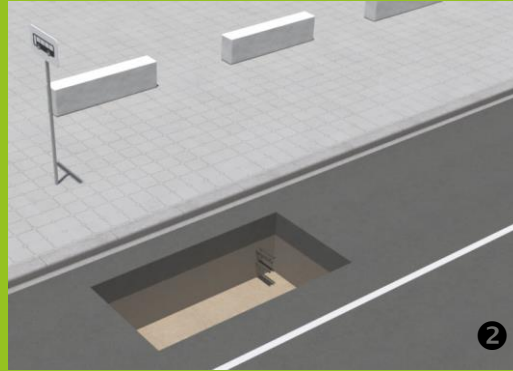
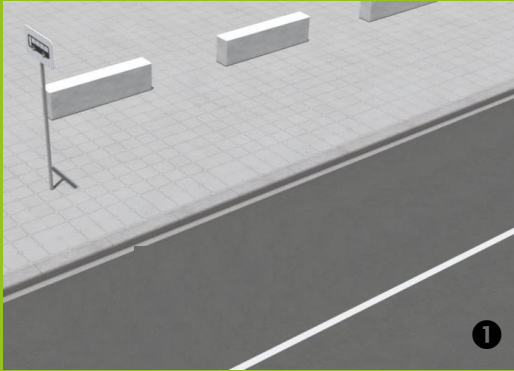


Increased Comfort, Safety & Efficiency

- Higher vehicle availability, potential for greatly reduced energy storage capacity and lower operating costs
- Hands-free automated charging serving the future of mobility
- No extra batteries are needed (for battery swapping)
- Due to smaller batteries, less weight needs to be moved

- ❶ Track Supply
- ❷ Primary Coil
- ❸ Secondary Coil
- ❹ Rectifier
- ❺ Battery
- ❻ Communication System





① Installation site (i.e. Bus Stop)

② Excavation with connection to grid

③ In-Ground Module installed

④ Charge Module connected

⑤ Finished Charge Station operational

