(I DON'T) MIND THE GAP

Discontinuous Electrification as part of the Railway System

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AtkinsRéalis

THE PWI
EMPOWERING RAILWAY ENGINEERING

AGENDA

1. What is Discontinuous Electrification?
2. Types of Discontinuity
3. Deadly sins or Wonders of the World? The seven modes of DE
4. DE: temporary or permanent?
5. Feasibility and compromises of DE
6. DE and the forgotten customer - freight
7. Appropriate use cases for DE

WHAT IS DISCONTINUOUS ELECTRIFICATION?

Discontinuous Electrification did not exist as a term before 2015.

Now it is talked about everywhere. But what actually *is it*?

DISCONTINUOUS ELECTRIFICATION: THE ATKINSRÉALIS DEFINITION

"A railway traction system where there is not a continuous live contact system above or below an electric train for the whole length of its journey; and where electric power is provided to the train via current collection equipment[1] for the purpose of propulsion[2] and/or energy storage when the train is moving[3] and/or when the train is stationary[4]."

1.This could be a pantograph, trolley pole, shoegear or plug-connector
2.And auxiliary loads
3.In-Motion Charging (IMC)
4.Static Charging (SC)

DE: THE ATKINSRÉALIS DEFINITION

Our definition is scoped as widely as possible.

Specifically includes electro-diesel bi-modes.

Allows consideration of all approaches to electrification and decarbonization.

Shows how complex the picture is.

How can we simplify the picture?

THE SEVEN MODES OF DISCONTINUOUS ELECTRIFICATION

Mode 0:
Conventional electrification.

Mode 1:
Continuous electrification with non-electrified diverging branches or sidings.

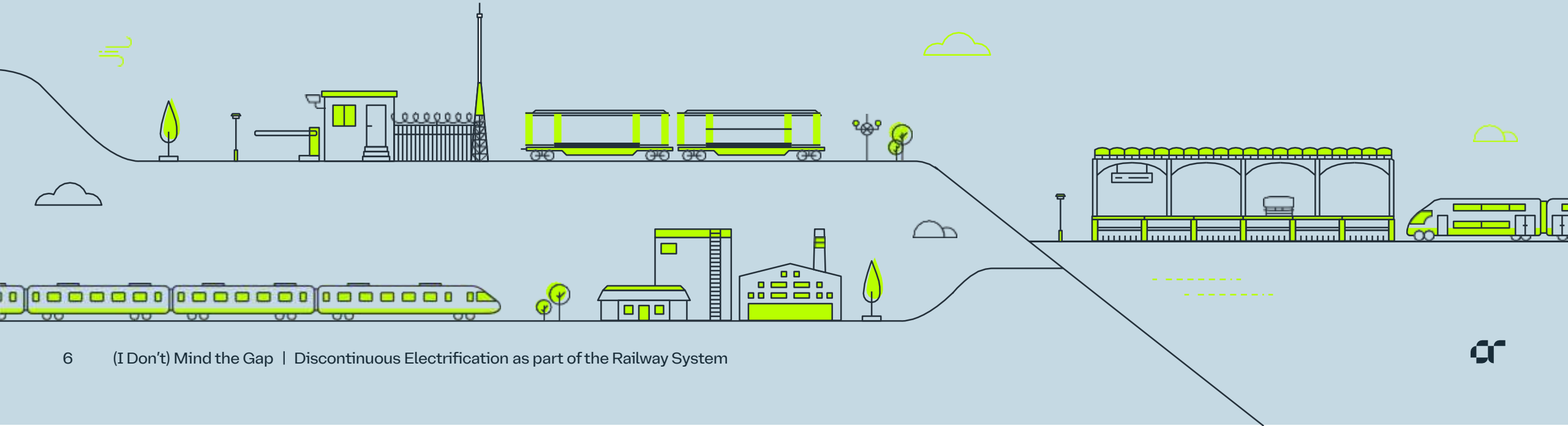
Mode 2:
One short discontinuity within an otherwise continuous system.

Mode 3:
Many short discontinuities, but still a mostly continuous system.

Mode 4:
Islands of electrification with multiple long discontinuities.

Mode 5:
Static charging facilities at stations, with no contact system in between.

Mode 6:
No electrification.



DE: TEMPORARY OR PERMANENT?

Temporary Uses:

- Part of a rolling programme of electrification
- Because a remodelling scheme is due to be undertaken in the gap.

Permanent Uses:

- As an end state, with no plan to close the gap.

The first scenario is the most effective way to roll out Continuous Electrification - and is needed for freight.

Scenario two is increasingly proposed, and the rest of this talk will focus on the idea of DE as a permanent state.

DE FEASIBILITY

- System Integration
- Operations
- Rolling Stock
- Static Charging
- In-Motion Charging
- Power Changeover

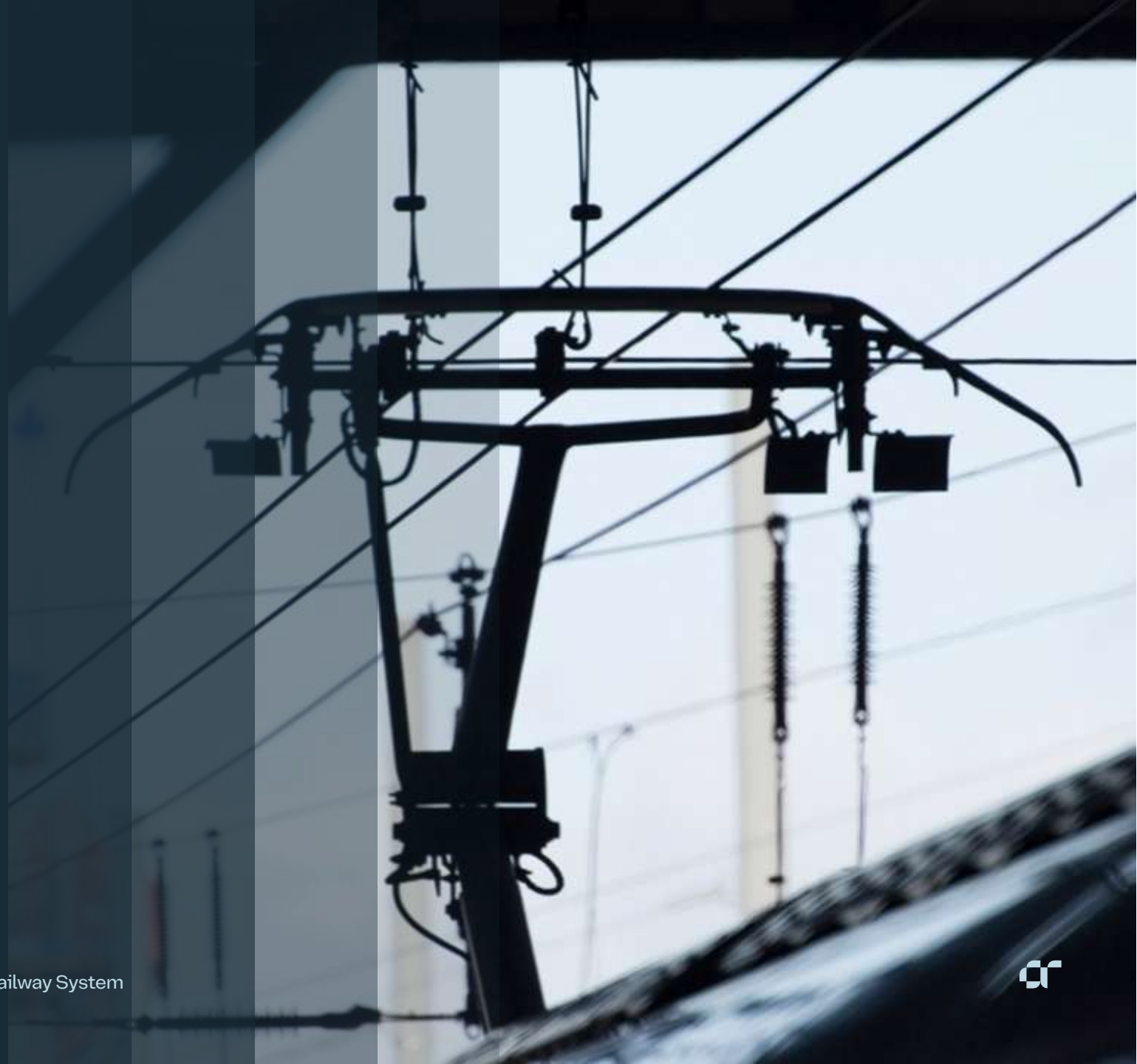
SYSTEM INTEGRATION

DE requires a fundamentally different approach to specification, procurement and design.

Rolling stock, infrastructure and operations are part of a single system in a way that is not the case with Continuous Electrification.

Sponsors, operators, rolling stock manufacturers, infrastructure managers, programme delivery and supply chain need to be tightly integrated and working to a common goal.

Requirements need to be clearly set out and agreed before the project starts.



OPERATIONS

Essential factors to define for DE:

- Service pattern
- Dwell times for static charging
- Power availability
- Stabling and overnight charging
- Service disruption
- Battery lifecycle
- Battery warranty
- Low temperature performance
- End-of-life performance
- Power changeover locations

ROLLING STOCK COMPROMISES

- Higher rolling stock capex
- Higher rolling stock opex
- Potentially lower reliability
- Bi- and tri-mode vehicles complexity
- Cost of conversion provision
- Diesel maintenance requirements
- Manufacturer reluctance on diesel
- Limitations on cascade

STATIC CHARGING

Static Charging (Mode 5) is more challenging than other modes because:

- Charge time is minimised
- Charging current and battery degradation is maximised
- Risk of contact patch damage if currents are too high

The golden rule: infrastructure constraints (charging availability) should not be constraining operational needs (dwell times)

How do we avoid proliferation of charging systems? The railway is built on common standards

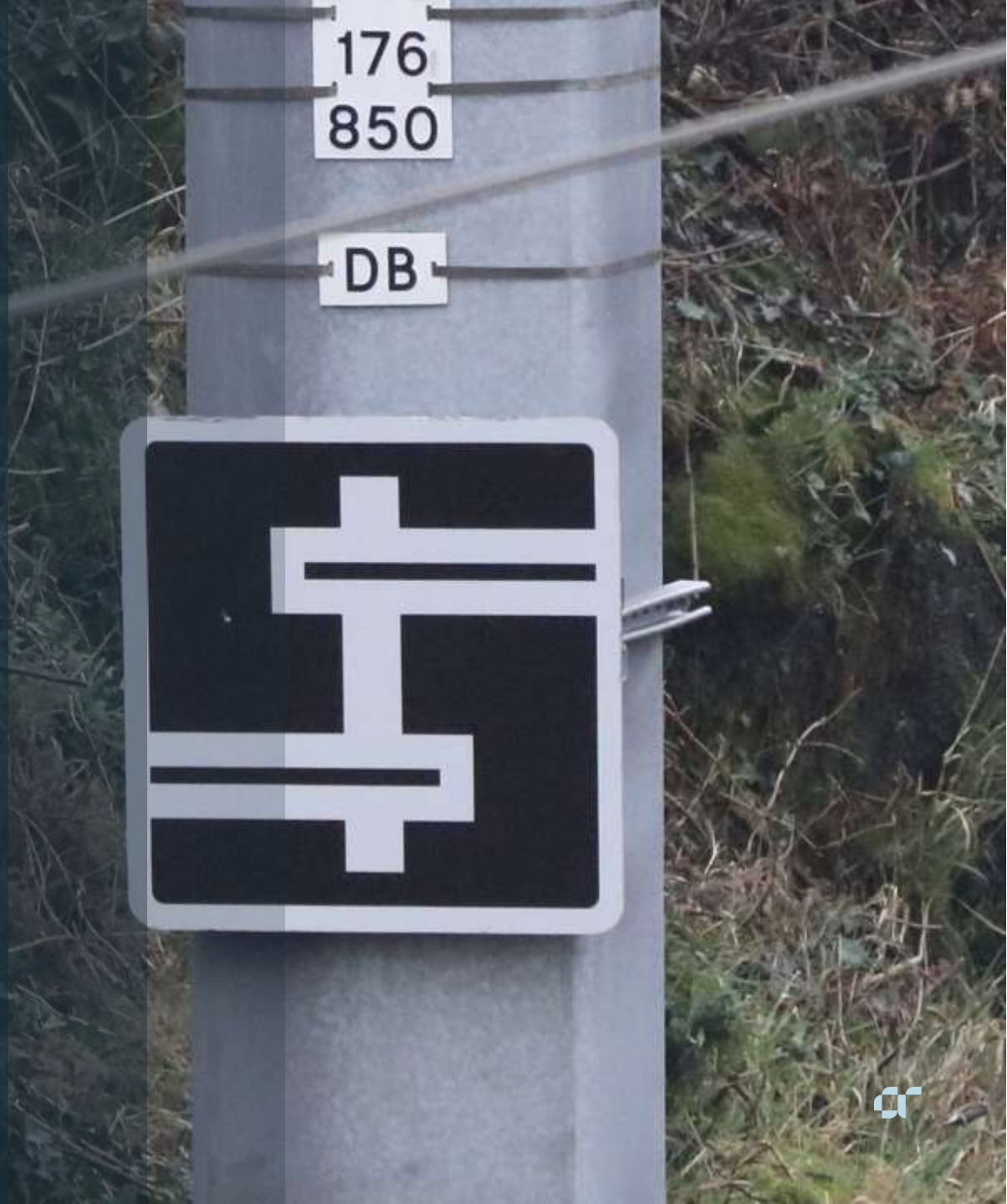
IN-MOTION CHARGING

In Motion Charging is less demanding than SC (lower currents, no dwell time constraints), **BUT**

- OCS currents are higher: traction current + charging current
- OCS system needs to be designed (or upgraded) to allow for total current
- Existing traction power supplies may need to be upgraded to allow for additional power

POWER CHANGEOVER

- Power changeover between modes is complex and must be planned from the start
- At higher speeds a considerable length of track is needed
- Must be away from signals, bridges and other features
- Power changeover can in some circumstances require more OCS to be built, increasing costs



THE FORGOTTEN CUSTOMER - FREIGHT

- DE, with the exception of Modes 1 and 2, is not an option for freight, now or for foreseeable future
- Power demand is simply too high
- DE as a permanent solution risks locking freight out of decarbonization
- Freight electrification has other benefits - increased capacity on busy lines

APPROPRIATE USE CASES FOR DE

- A single discontinuity to deal with a problem with no practical engineering solution
- Last-mile branch line capability in coordination with continuous electrification on the mainline
- Temporary discontinuities as part of a staged and coordinated rolling programme of electrification
- Short, self-contained routes with no freight where island charging can be provided
- Multiple discontinuities on a self-contained passenger-only network
- Multiple discontinuities on a mixed use passenger and freight railway, as part of a longer term strategy to close the gaps for freight

SEE YOU IN THE BREAKOUT SESSION!