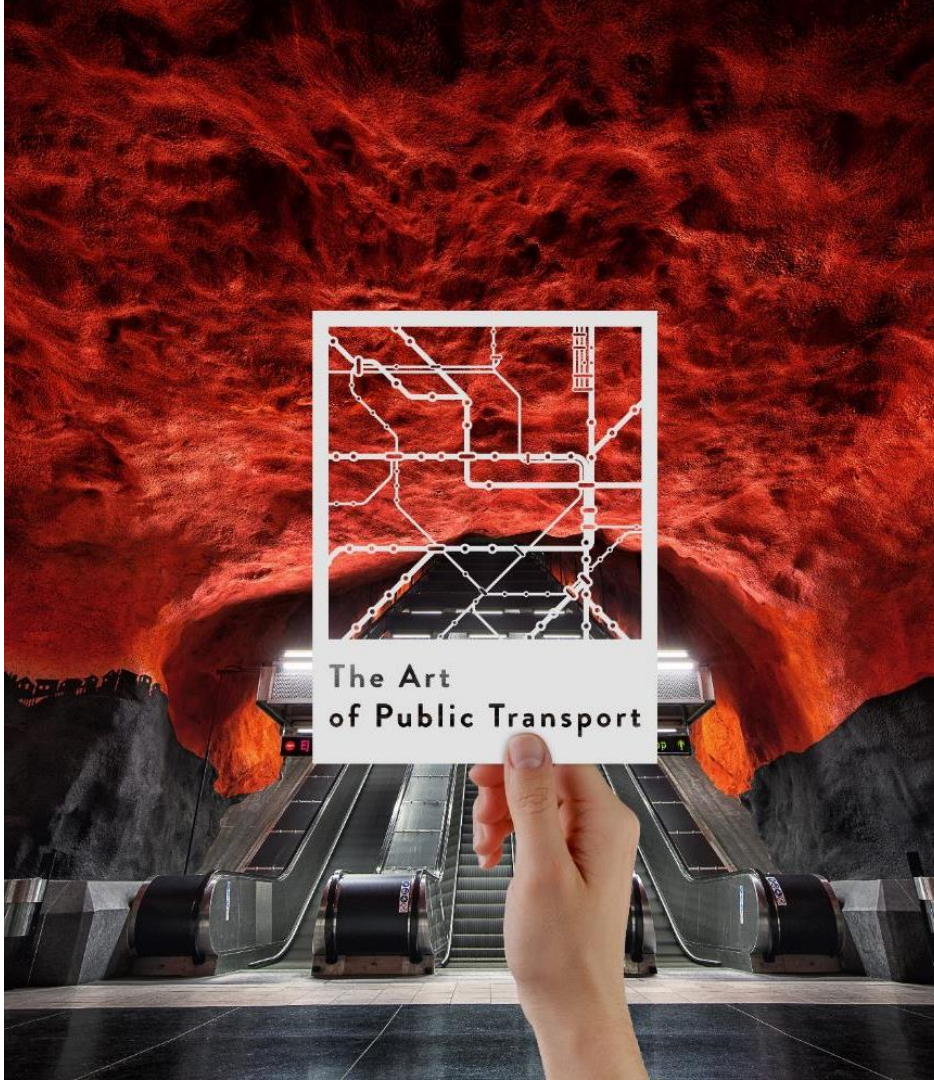
9-12 JUNE
STOCKHOLM 2019
GLOBAL PUBLIC TRANSPORT SUMMIT

Best practices for planning and scheduling E-Buses

Houari Cheikhi

Director, Business Development, GIRO Inc.



Charging challenges

CHARGING METHODS

Conductive

Cable at the depot	Manual connection Large battery capacity Slow charging (Overnight charge)
Catenary at terminals and bus stops	Automatic pantograph Small capacity battery Fast charging

Inductive

Inductive along the route	Automatic, no contact Small capacity battery Fast charging

greencarcongress.com

CHARGING MODES

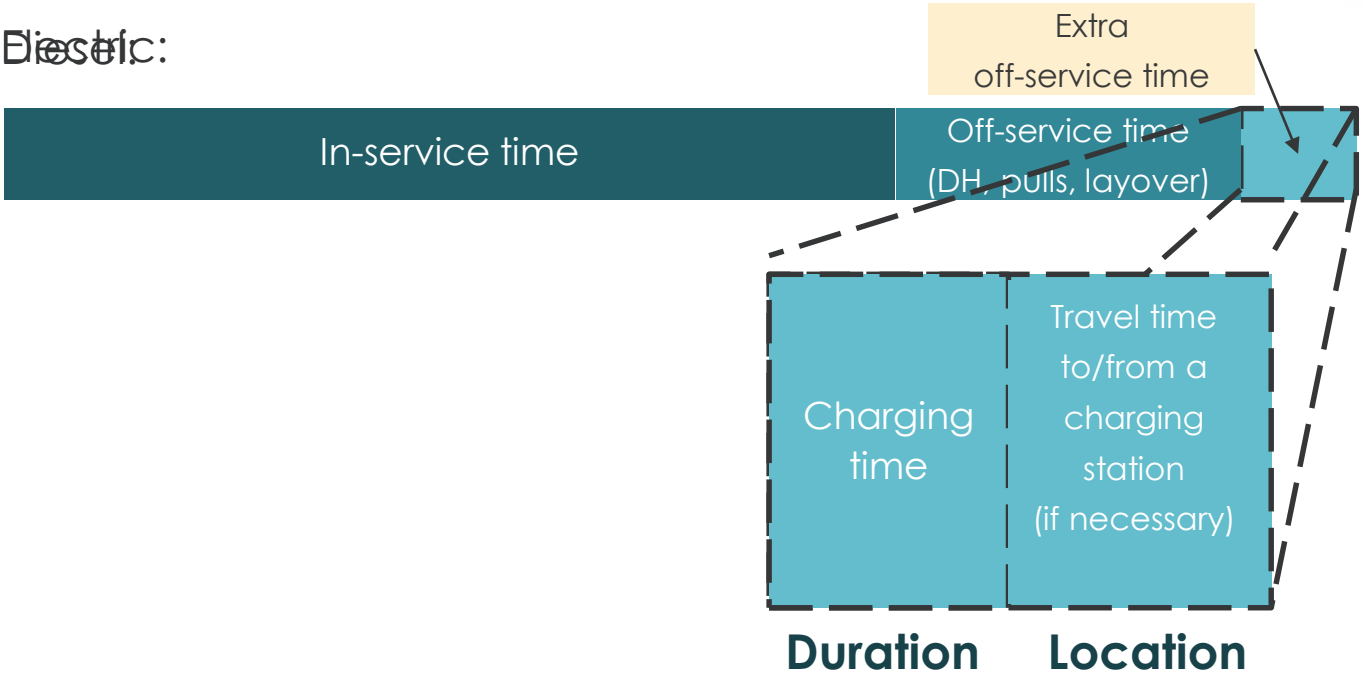
9-12 JUNE
UITP STOCKHOLM 2019
GLOBAL PUBLIC TRANSPORT SUMMIT

	Charging mode	Charging location	Charging time	Max. charge	Range/charge (km)
Diesel	**Diesel**	Depot	0h05	100%	650
E-buses (Existing VDL 170 KW)	**Slow**	Depot	<= 2h16	100%	76.5
	Fast	Terminal	0h10–0h20	90%	17–34
	Very fast	Within trips	0h10–0h20	90%	8.5–29.5

CHARGING CONSTRAINTS

Diesel:

Electric:



Might require more e-buses than diesel for same service

AUTONOMY (RANGE)

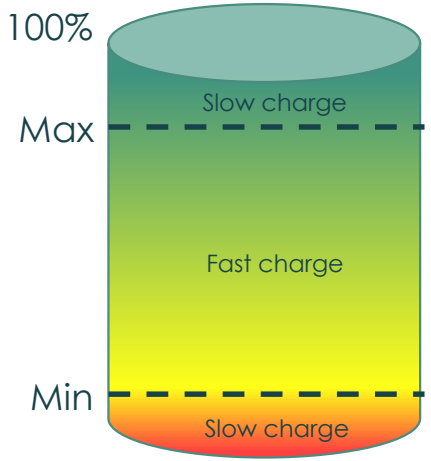
Even with slow charging, max range is ~250 km, so e-buses:

- **Cannot operate** longer blocks as is
- **Can operate** shorter blocks, with charging duration/location as new constraints

BATTERY LIFESPAN

On network, **fast charging** only allowed within "safe" fast-charge interval (min/max %) to preserve battery lifespan

At depot, **slow charging** allows full recharge, without damaging battery



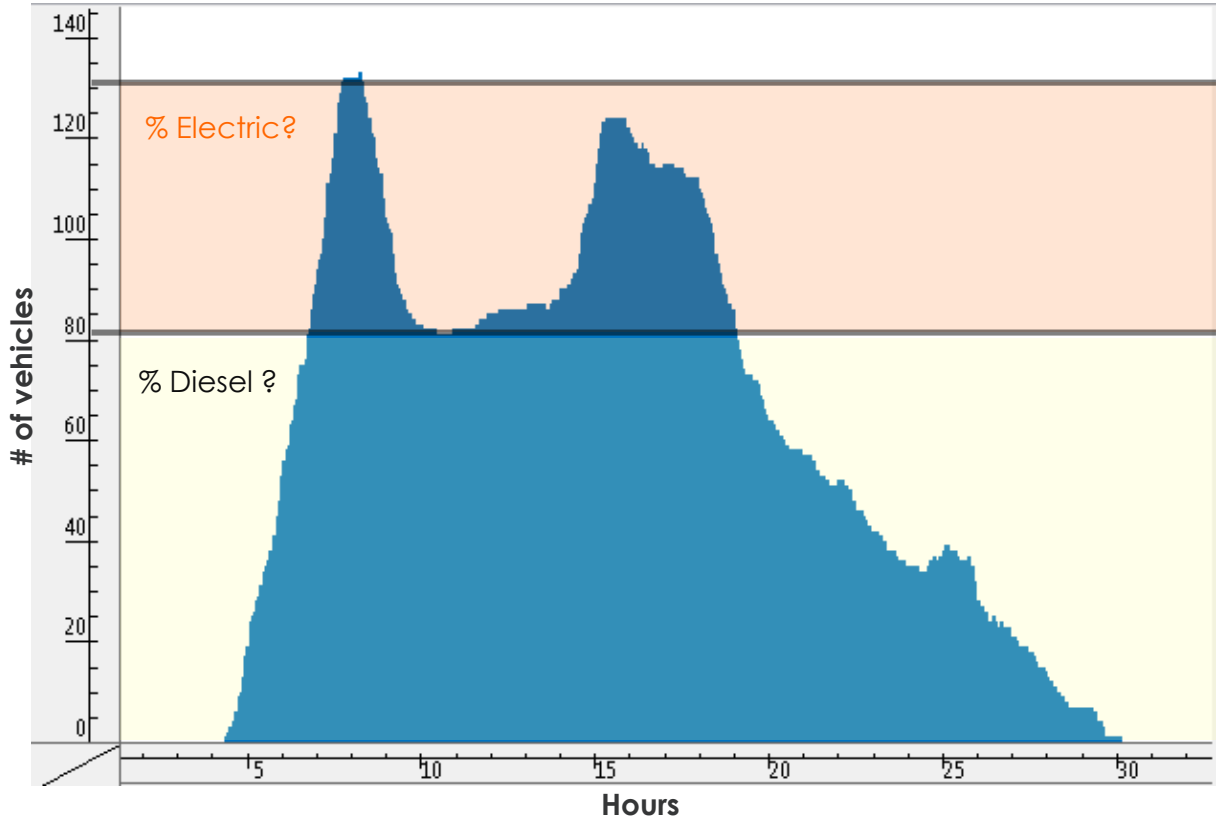
KEY CONSIDERATIONS

Autonomy (range)	Modelling battery capacity and consumption rate
Charging duration	Modelling for different battery technologies
Charging location	Modelling for different charging modes
Battery lifespan	Avoiding fast charging outside “safe” interval

Taking these considerations into account, ***HASTUS*** allows you to establish fact-based scenarios to prepare the move to electrification

Planning and Scheduling challenges

CASE 1: START SMALL

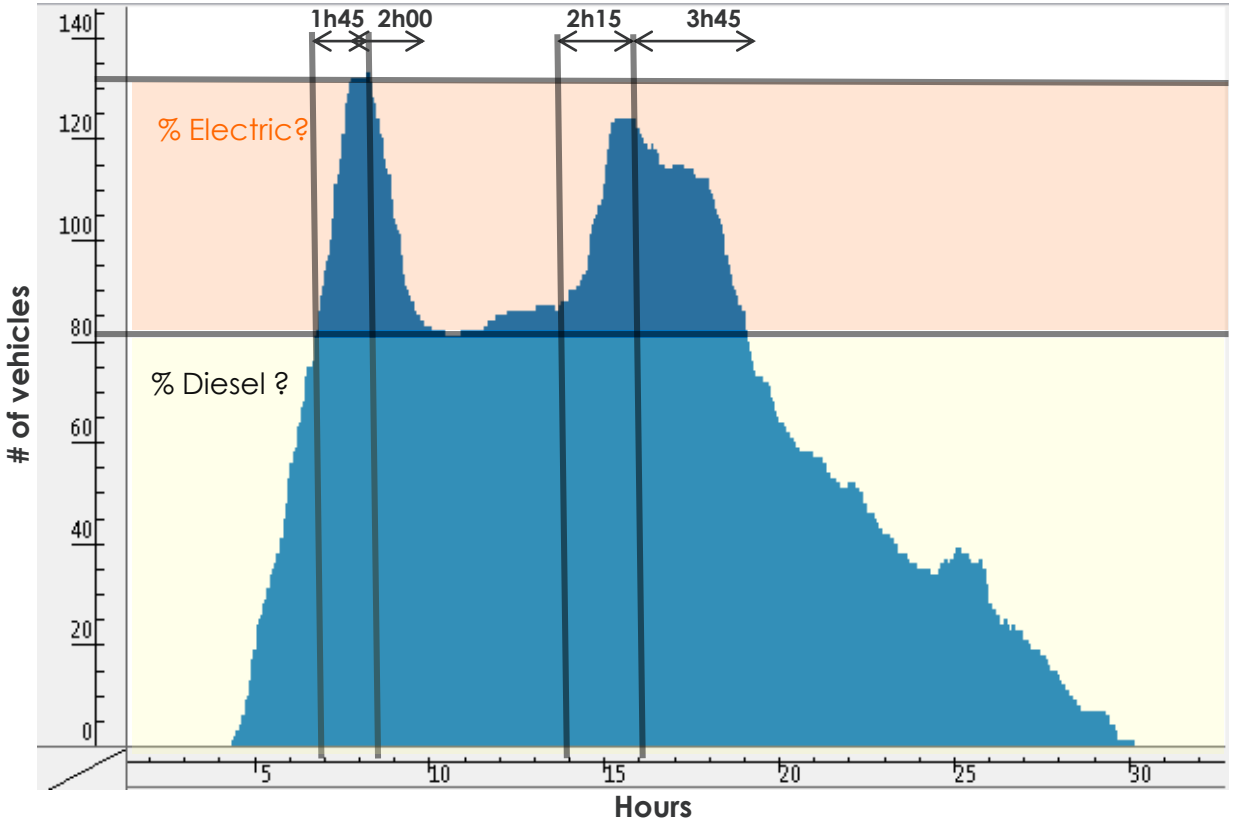


CONTEXT

Service with well-defined peaks. Assuming charging at depot only

Can you integrate e-buses into your fleet without changes?

CASE 1: START SMALL

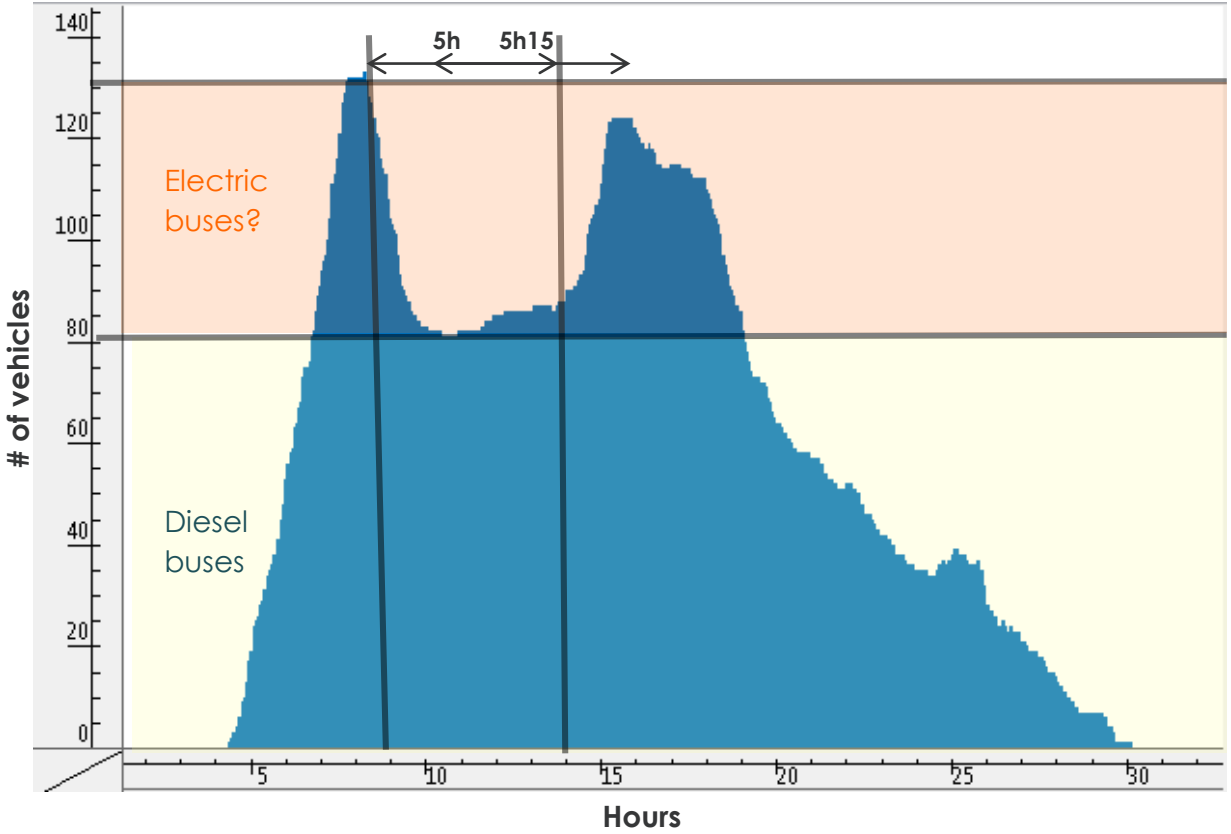


Assuming average speed of 16–20 km/h

Autonomy?

Needs at least 3h45 (i.e. 60–75 km)

CASE 1: START SMALL



Assuming average speed of 16–20 km/h

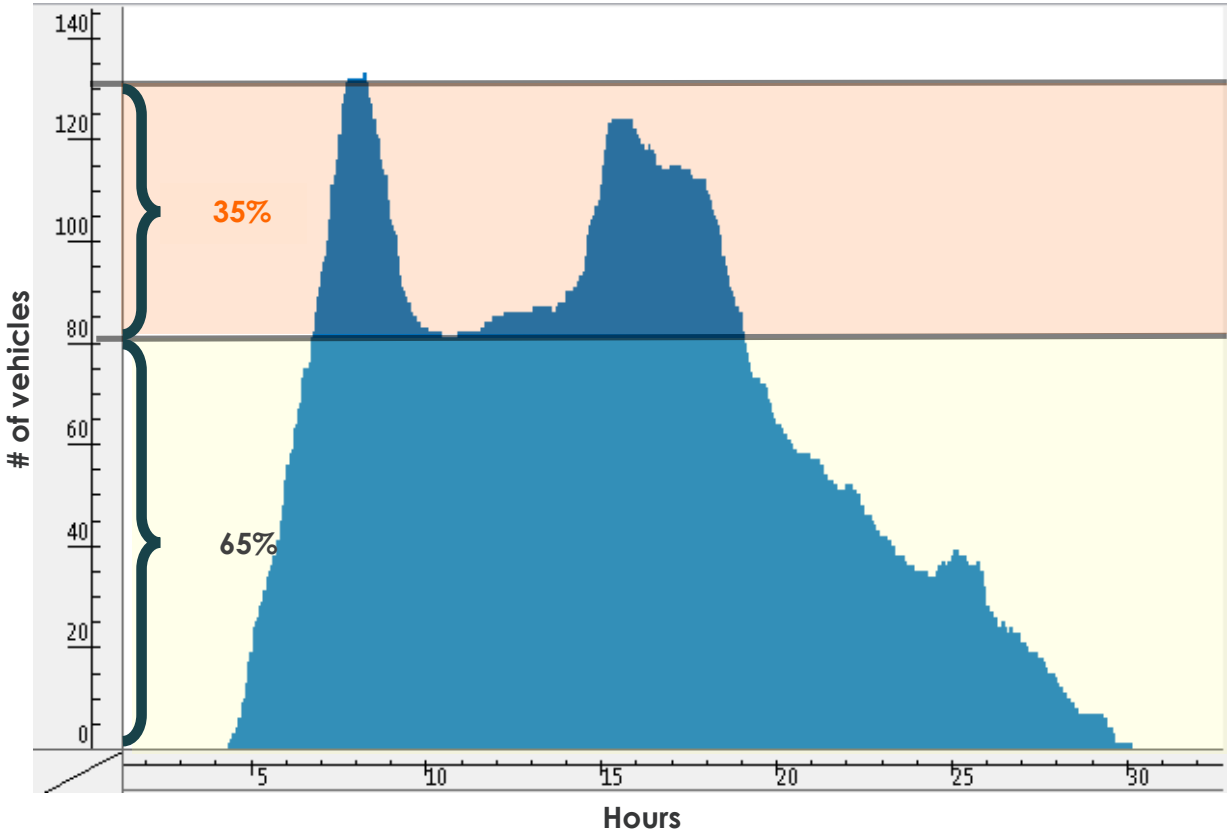
Autonomy:

Needs at least 3h45 (i.e. 60–75 km)

Charging?

Charging time between peaks must be at most 5h00

CASE 1: START SMALL



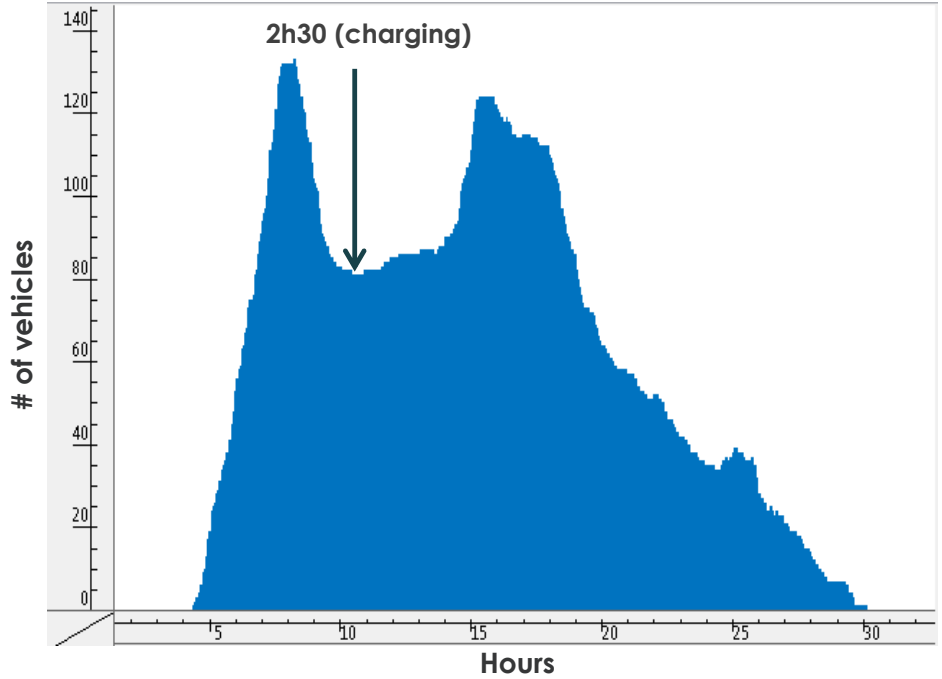
35% e-buses without modifying schedule

CASE 2: SCALE UP

Can you operate the same service with even more e-buses, without increasing the total fleet size?

Assuming:

- Charging at depot only
- Autonomy of 120 km
- Charging time of 2h30



CASE 2: SCALE UP

Can you operate the same service with even more e-buses, without increasing the total fleet size?

YES. By optimizing blocks using rules that ensure:

- They all return to depot before running out of charge
- Some recharge during off-peak times, so that next block can be operated
- No increase in total fleet size

HASTUS was able to produce a solution with…

…**50%** e-buses

CASE 3: FULLY ELECTRIC

Can you operate with an all e-bus fleet?

YES. By optimizing blocks using rules to ensure:

- Buses return to depot before running out of charge
- They all recharge so that next block can be operated
- No restrictions regarding total fleet size

HASTUS was able to produce an all e-bus solution with…
…only **9%** more buses

CONCLUSION

E-buses have become commonplace in small, medium and large cities.

They bring with them special constraints and considerations.

HASTUS allows you to gradually integrate e-buses into your fleet and control the impact on your operations:

1. **First:** start with a fair **35%** e-bus ratio without scheduling changes
2. **Second:** scale up to a good **50%** e-bus ratio with minimal scheduling changes
3. **Then:** achieve a **100%** e-bus ratio with a limited fleet-size increment

UITP 9-12 JUNE STOCKHOLM 2019 GLOBAL PUBLIC TRANSPORT SUMMIT

GIRO

THANK YOU

Houari Cheikhi
Director, Business Development, GIRO Inc.

www.giro.ca

Local Host SL

#UITP2019