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« Hybrid Freight locomotive between Hotazel – Coega track using EMR and Simulink »

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Hybrid Freight locomotive feasibility using EMR & Simulink



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« **PART 1: BACKGROUND** »

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- SA Freight Railway Network -

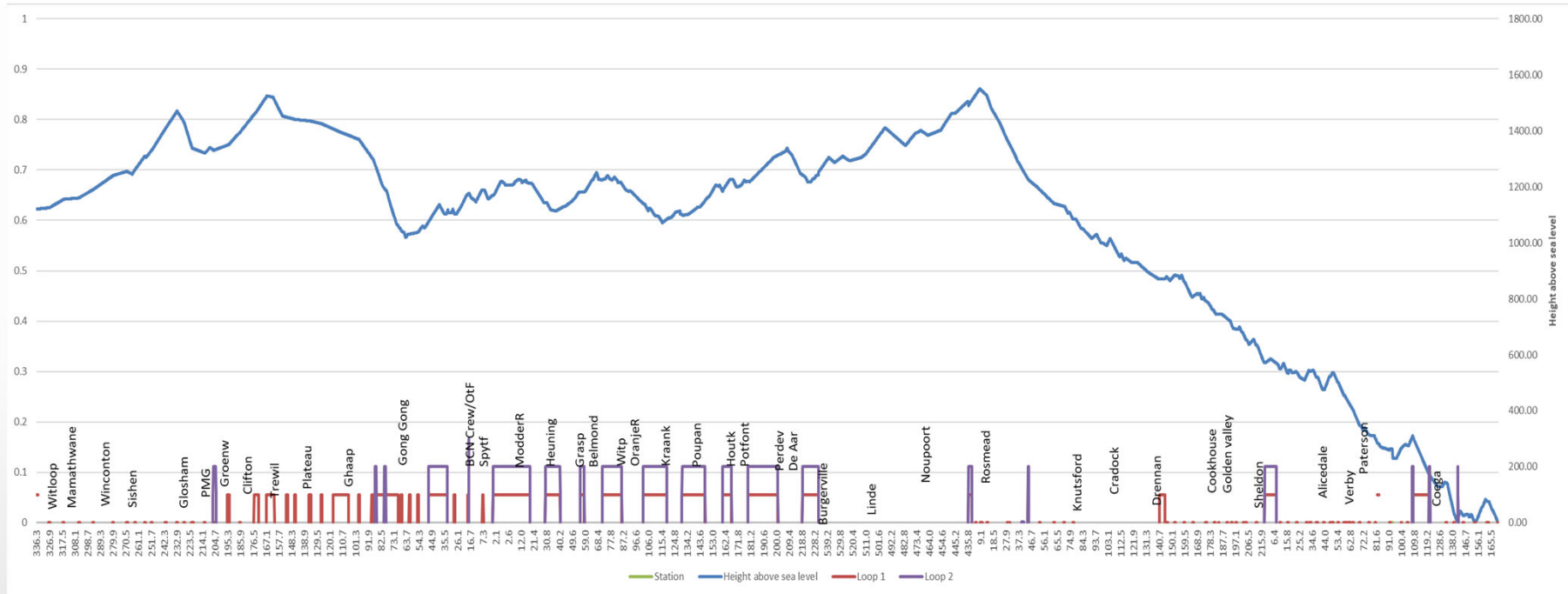
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Hotazel to Coega Port Track topology

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Ruling Gradient:	: 1:80
Length:	: 1078 kilometers
Travel time	: 23 hours
Maximum speed	: 40 – 70 km/h



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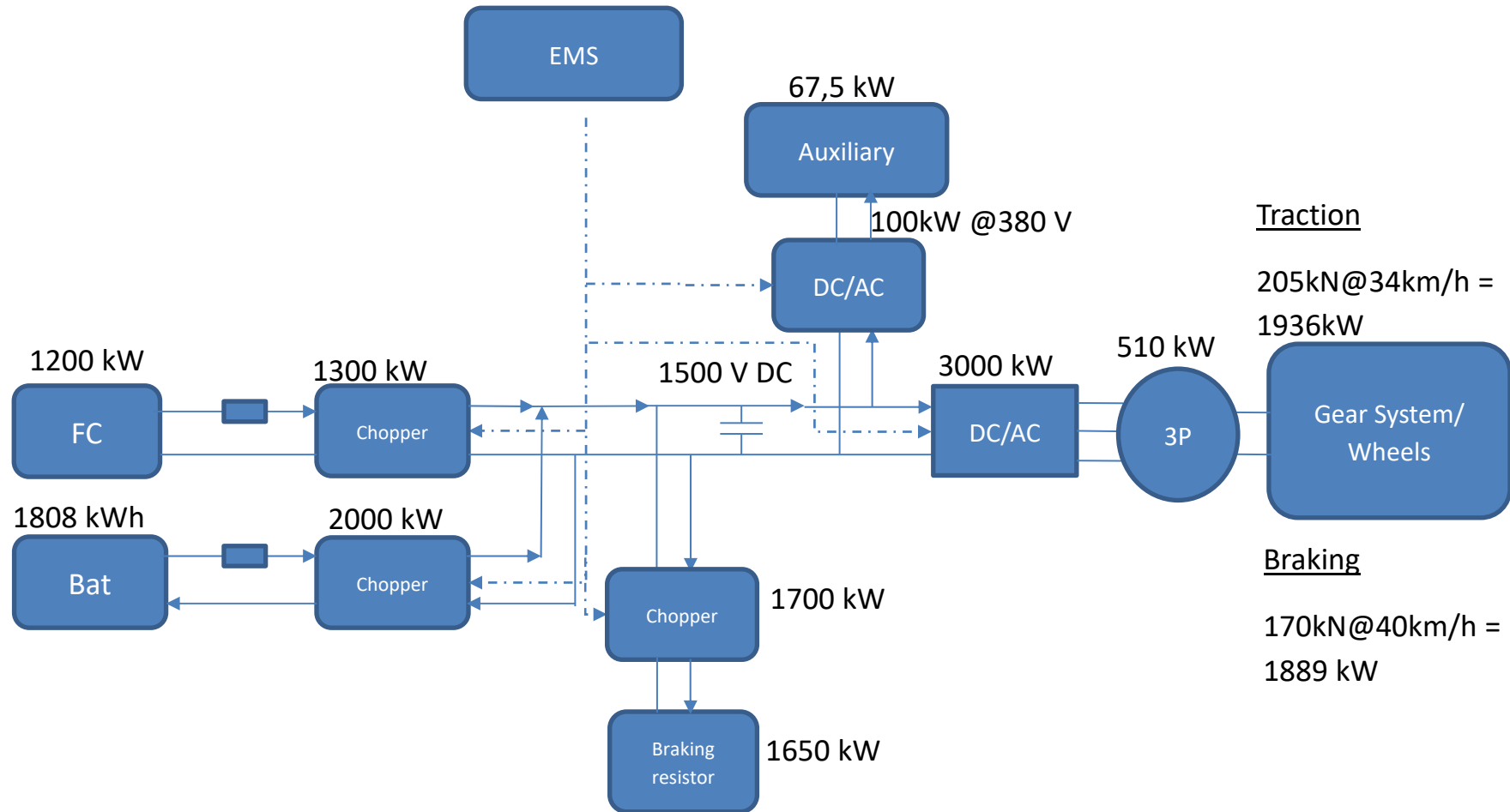
« PART 2: STUDIED LOCOMOTIVE »

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- Studied Locomotive -

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Train consists

6 Hydrogen FC Locomotives

104 Wagons

Each Locomotive

-200kW Fuel cell x 6 = 1.2 MW

-425 x7 = 2975 cells = 1.8 MWh

IEEE VTS 2019 Challenge

-IEEE VTS Challenge adapted.

Why?

-Fuel cell data

-Hydrogen consumption algorithm

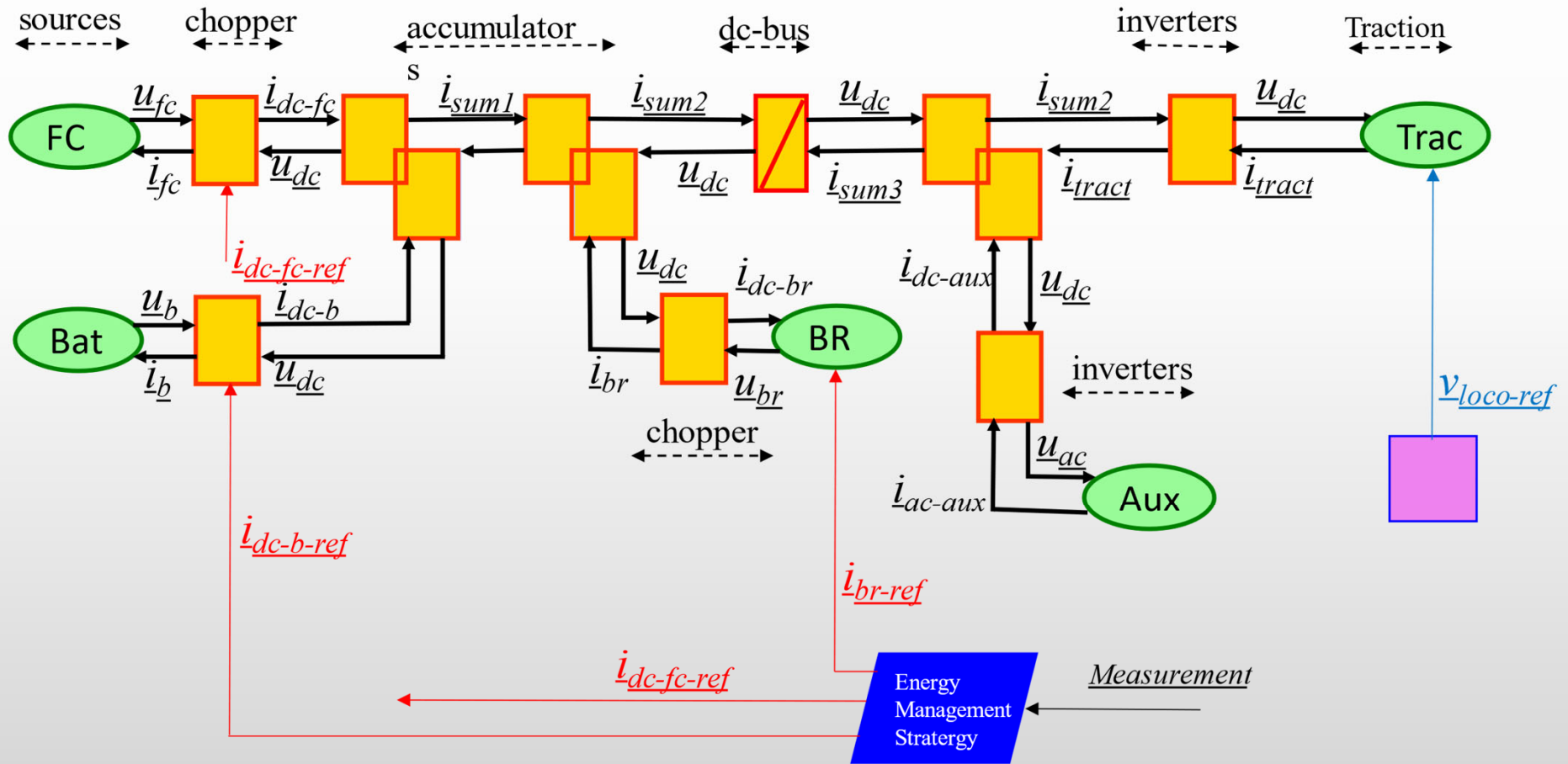
-Battery data

-Introduction to EMR application

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EMR Representation of Studied Locomotive

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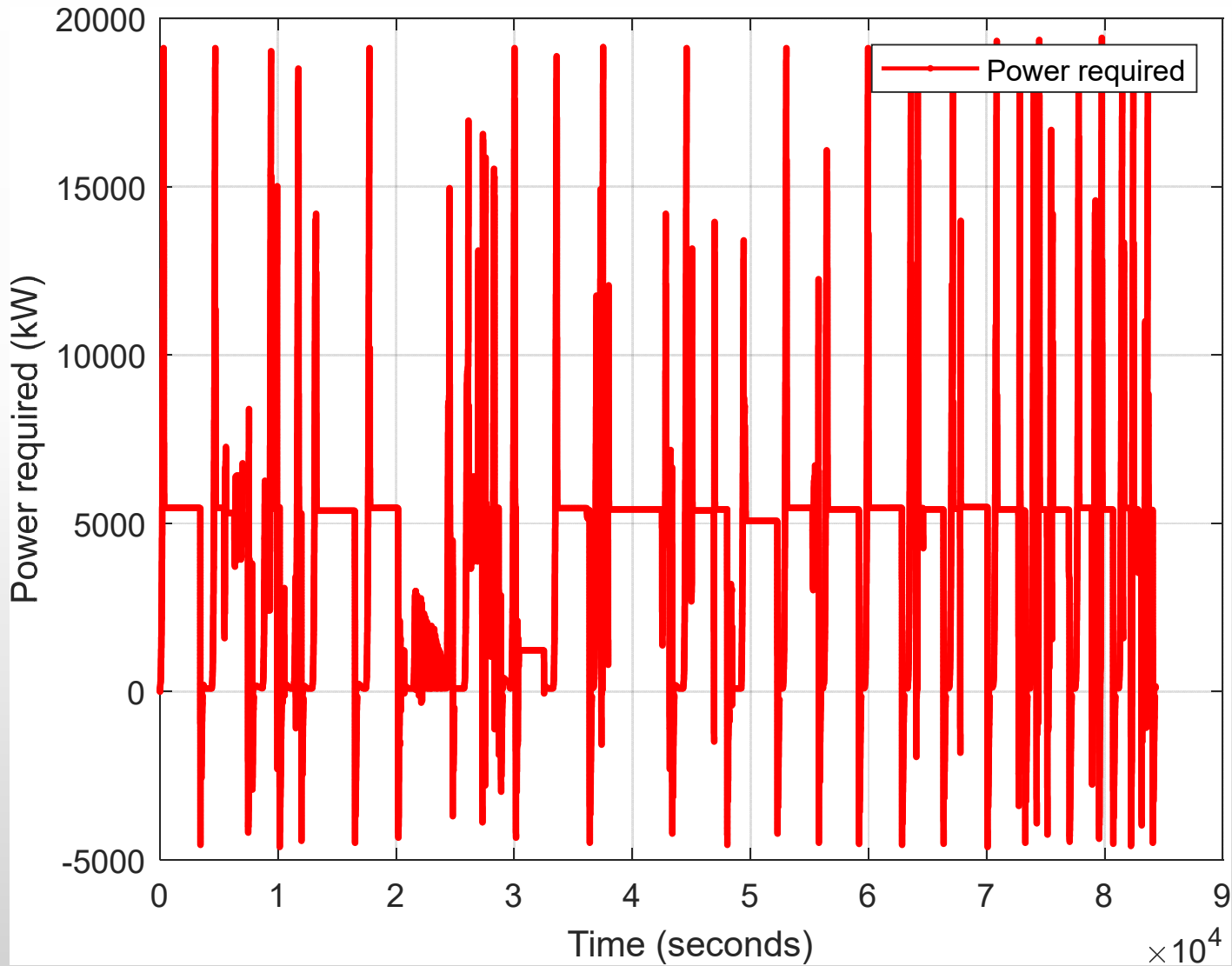
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« PART 3: RESULTS & SUMMARY »

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Power demand by the locomotive

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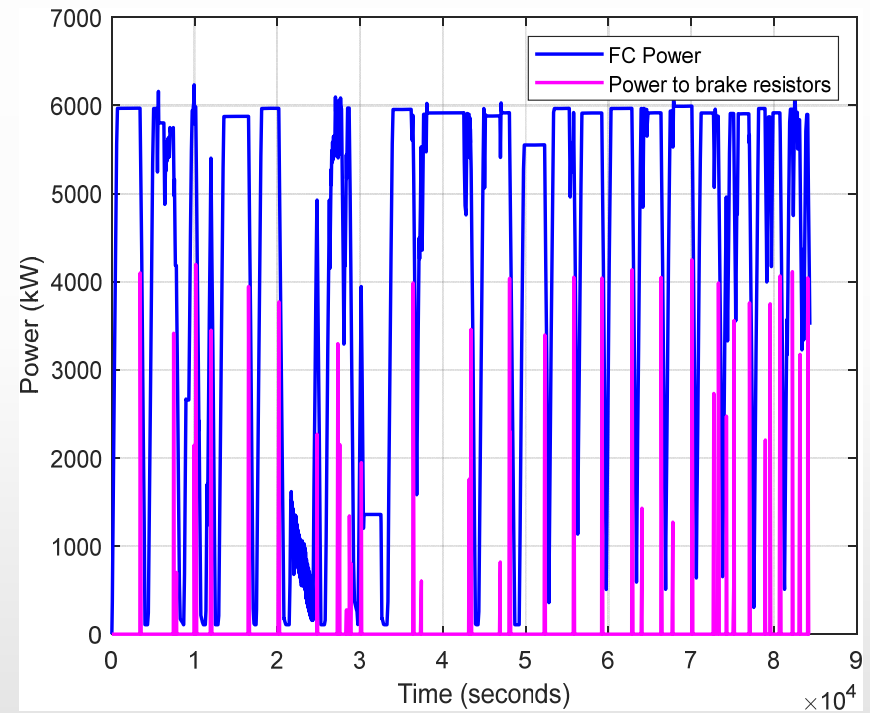
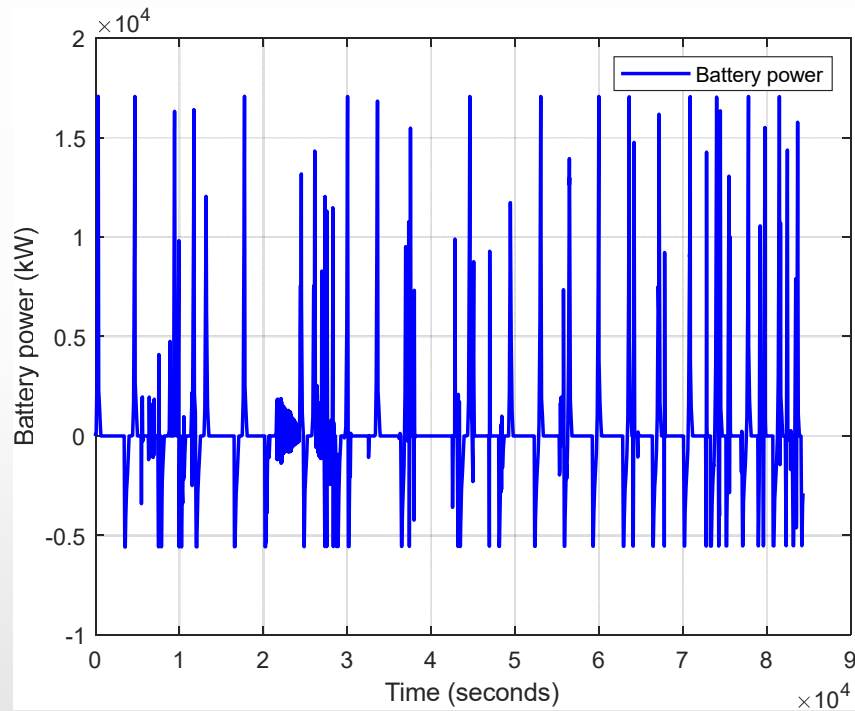


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Power distribution

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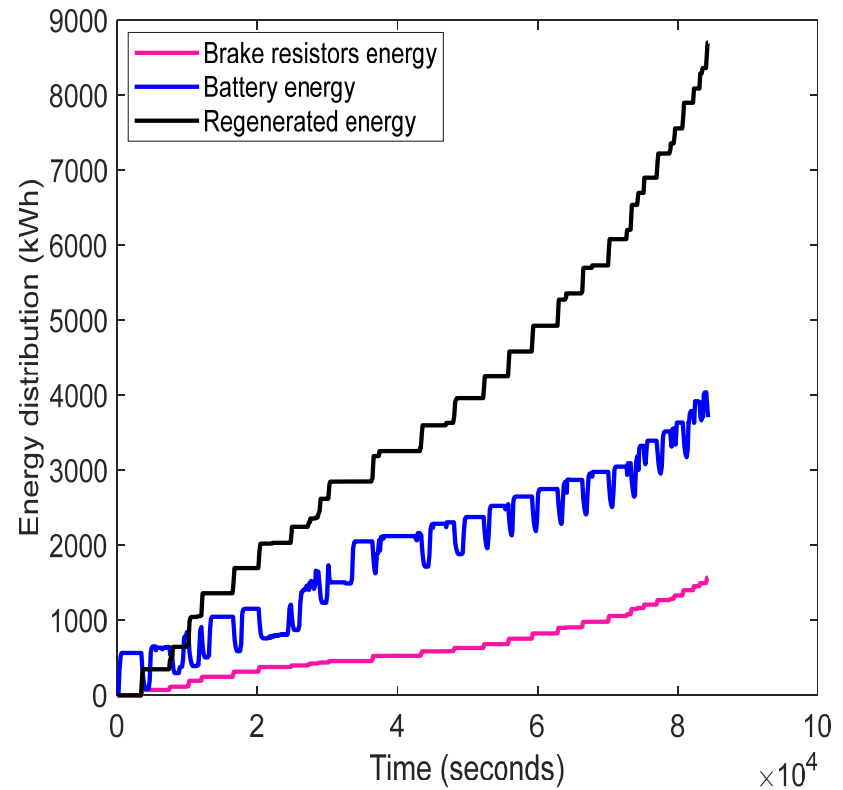
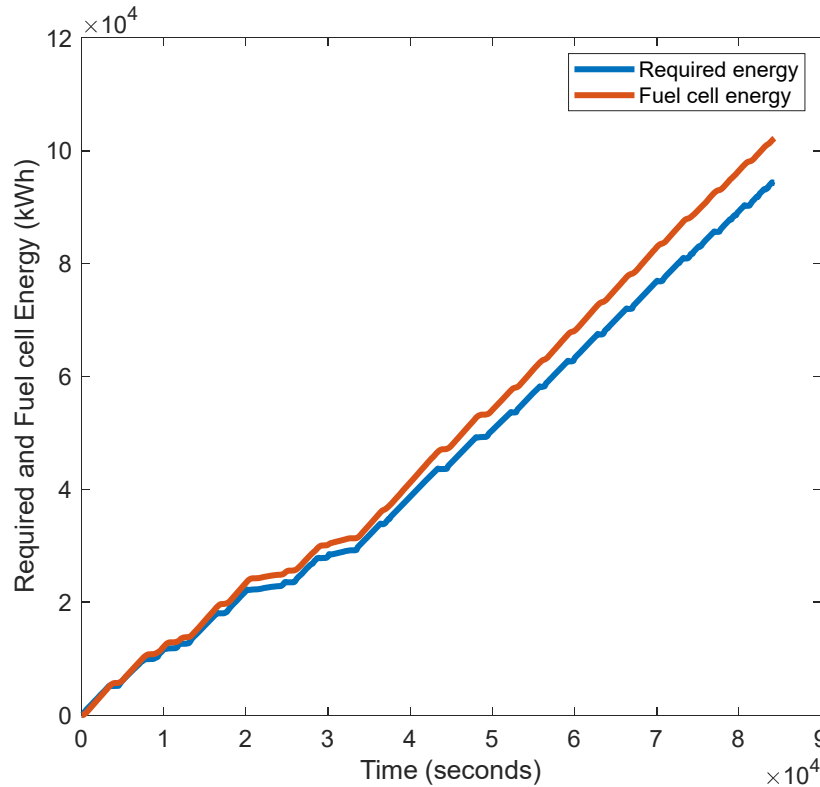
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Energy distribution

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Loco	Traction	Fuel cell	Battery	Regen	Brake Res
6x H2 loco	94 MWh	102 MWh	3.8 MWh	9 MWh	1.5MWh

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Conclusion

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It is technical viable

Comparisons

6 x Hydrogen locomotives

3 x 23E

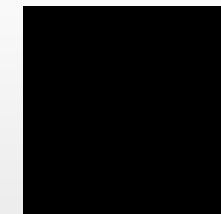
4 x D43



6 loco , 104 wagons



Battery,



Fuel cell



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« BIOGRAPHIES AND REFERENCES »

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- Authors -

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- Trevor J Downward (2x N. Dip (Elect & Mech) - Rolling Stock Design
- Willem Kuys (Civil Engineer) - Perway and Running times expert
- Sid Herbert (2 x N. Dip (Elect & Electronics) - Locomotive expert.
- Andre van der Walt (M.Eng Elect) – Matlab & EMR specialist.
- Dr Mark Gordon (PhD in Applied Physics) -Traction Motors
- Gideon Coetzee – (B.Eng Elec) -Transnet

- References -

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[Lhomme et al. 2018] W. Lhomme et al., "IEEE VTS motor vehicles challenge 2019 – Energy management of a dual-mode locomotive," 2018 IEEE Vehicle Power and Propulsion Conference, VPPC 2018 - Proceedings, 2019, doi: 10.1109/VPPC.2018.8605044.

[Bouscayrol 2012] A. Bouscayrol, J. P. Hautier, B. Lemaire-Semail, "Graphic Formalisms for the Control of Multi-Physical Energetic Systems", Systemic Design Methodologies for Electrical Energy, tome 1, Analysis, Synthesis and Management, Chapter 3, ISTE Willey editions, October 2012, ISBN: 9781848213883