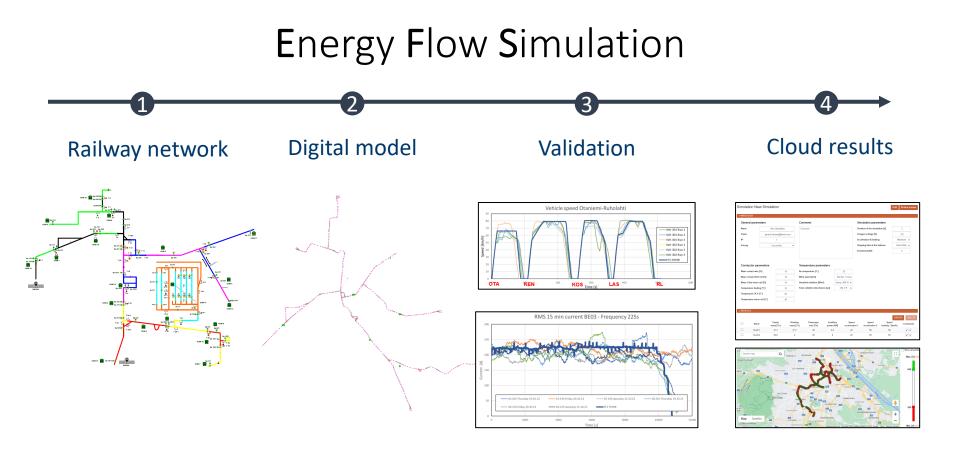


Gerald Clariana Kruch Railway Innovations



EFS: Energy Flow Simulation

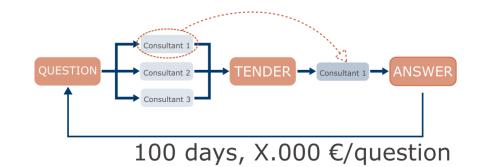
Your light rail network in your hands



Features of EFS

Energy Flow Simulation Traditional





nulation	n New Sir	nulation					R	UN Sack to in
INPUT DATA	Ą							
General p	parameters		Simula	tion parameters		Conductor para	ameters	
Name		New Simulation	Duration	of the simulation [h]	3	Wear contact wire	%]	10
Email		ferran.rovira@kruch.com	Chopper	voltage [V]	720	Wear of steel third	rail [%]	10
N°		1	Accelera	ation & braking	Maximum	• Wear of the return	ail [%]	10
Priority		Low priority	✓ Stopping	g time at the stations	Fixed (20s)	• Temperature feedin	g [°C]	70
			Investme	ent [k€]	0	Temperature OCS [°C]	50
						Temperature return	rail [°C]	40
VEHICLES								CREATE
	Name		Rotating Jass [Tn]			peed Speed leration 1 acceleration	Speed	Command
	Name Kruch1				wer [kW] accel		Speed	Command
		mass [Tn] m	ass [Tn]	load [Tn] pov	wer [kW] accel 4.6	eration 1 acceleration	Speed 2 braking 1 [km	Command
	Kruch1	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] pov 25	wer [kW] accel 4.6	22 50	Speed 2 braking 1 [km 56 56	/h] Command
	Kruch1 Kruch2	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] pov 25	wer [kW] accel 4.6	22 50	Speed 2 braking 1 [km 56 56	/h] Command
	Kruch1 Kruch2	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] pov 25	wer [kW] accel 4.6	22 50	Speed 2 braking 1 [km 56 56 Showi	Command Command Call
TIMETABLE:	Kruch1 Kruch2	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] pov 25	wer [kW] accel 4.6	22 50	Speed 2 braking 1 [km 56 56 Showi	CREATE DELE
TIMETABLE	Kruch1 Kruch2 S	mass [Ĩn] m 41.7 40.8	ass [Tn] 4.17 4	load [[n] pov 25 20 Frequency	wer [kŴ] accel 4.6 6 Offset	eration 1 acceleration 22 50 22 50 Passengers	2 Speed braking 1 [km 56 Show Start	Command Command Call and Call and Cal
	Kruch1 Kruch2 S	mass [Tn] m 41.7 40.8 Vehicle	ass [Tn] 4.17 4 Units per vehicle	load [Tn] pov 25 20 Frequency [min]	ver [kW] accel 4.6 6 Offset [min]	Passengers per vehicle [%]	Speed braking 1 [kr 56 Show Show time [min]	Vh] Command

imulatio	on New Si	mulation					RUN	Sack to inde
▼ INPUT DAT	ΤA							
General	l parameters		Simula	tion parameters		Conductor param	neters	
Name		New Simulation	Duration	of the simulation [h]	3	Wear contact wire [%]		10
Email		ferran.rovira@kruch.com	Chopper	voltage [V]	720	Wear of steel third rail	I [%]	10
N°		1	Accelera	ation & braking	Maximum 🔻	Wear of the return rail	I [%]	10
Priority		Low priority	✓ Stopping	g time at the stations	Fixed (20s) 🔻	Temperature feeding [[°C]	70
			Investme	ent [k€]	0	Temperature OCS [°C]]	50
						Temperature return ra	il [°C]	40
▲ VEHICLES	3						CRE	EATE DELETE
	S Name		Rotating nass [Tn]		ixiliary Spe ver [kW] acceler		Speed braking 1 [km/h]	Commande
				load [Tn] pow		ation 1 acceleration 2	Speed	Commande
	Name	mass [Tn] ma	ass [Tn]	load [Tn] pow	ver [kW] acceler	ation 1 acceleration 2 2 50	Speed braking 1 [km/h]	Commands
	Name Kruch1	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] pow 25	ver [kW] acceler 4.6 2	ation 1 acceleration 2 2 50	Speed braking 1 [km/h] 56 56	Commands
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] pow 25	ver [kW] acceler 4.6 2	ation 1 acceleration 2 2 50	Speed braking 1 [km/h] 56 56	Commands P = P =
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] pow 25	ver [kW] acceler 4.6 2	ation 1 acceleration 2 2 50	Speed braking 1 [km/h] 56 56 Showing	Commands
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] pow 25	ver [kW] acceler 4.6 2	ation 1 acceleration 2 2 50	Speed braking 1 [km/h] 56 56 Showing	Commands
TIMETABL	Name Kruch1 Kruch2	mass [[n] ma 41.7 40.8	aass [Tn] 4.17 4	load [Tn] pow 25 20 Frequency	er [kW] acceler 4.6 22 6 22 Offset	ation 1 acceleration 2 2 50 2 50 Passengers	Speed braking 1 [km/h] 56 56 Showing CRR Start	Commands Comman
□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □	Name Kruch1 Kruch2 LES	mass [[n] ma 41.7 40.8 Vehicle	uass [Tn] 4.17 4 Units per vehicle	load [Tn] pow 25 20 Frequency [min]	er [kW] acceler 4.6 22 6 22 Offset [min]	ation 1 acceleration 2 2 50 2 50 Passengers per vehicle [%]	Speet braking 1 [km/h] 56 56 Showing CRR Start time [min]	Commands Commands Commands Commands

INPUT DA	ATA							
	I parameters	4	Simula	ation parameters		Conductor param	neters	
Name		New Simulation	Duration	n of the simulation [h]	3	Wear contact wire [%]		10
Email		ferran.rovira@kruch.com	Chopper	r voltage [V]	720	Wear of steel third rail	[%]	10
N°		1	Accelera	ation & braking	Maximum 🔻	Wear of the return rail	[%]	10
Priority		Low priority	✓ Stopping	g time at the stations	Fixed (20s) 🔻	Temperature feeding [°C]	70
			Investm	ent [k€]	0	Temperature OCS [°C]		50
						Temperature return ra	il [°C]	40
VEHICLES	S	Empty Po	stating	Passonnor Au	viliany Spo	ed Speed		DELE
	S Name	mass [Tn] ma	otating ass [Tn]	load [Tn] pow	xiliary Spe er [kW] acceleri	ation 1 acceleration 2	Speed braking 1 [km/	
		mass [Tn] ma		load [Tn] pow		ation 1 acceleration 2	Speed	
	Name	mass [Tn] ma	iss [Tn]	load [Tn] pow	er [kW] acceler	ation 1 acceleration 2 2 50	Speed braking 1 [km/ 56 56	h] Command
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] pow 25	er [kW] accelen 4.6 22	ation 1 acceleration 2 2 50	Speed braking 1 [km/ 56 56	h] Command
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17 4	load [[n] pow 25 20 Frequency	er [kŴ] acceler 4.6 22 6 22 Offset	ation 1 acceleration 2 2 50 2 50 Passengers	Speed braking 1 (km/ 56 56 Showir Start	hj Command
	Name Kruch1 Kruch2 LES Line	mass [Ťn] ma 41.7 · 40.8 · Vehicle	4.17 4 Units per vehicle	load [Tn] pow 25 20 Frequency [min]	er [kŴ] accelen 4.6 22 6 22 Offset [min]	Ation 1 acceleration 2 2 50 2 50 Passengers per vehicle [%]	Speed braking 1 (km/ 56 56 Showir Start time [min]	h] Command
	Name Kruch1 Kruch2 LES	mass [Tn] ma 41.7 40.8	ass [Tn] 4.17 4	load [[n] pow 25 20 Frequency	er [kŴ] acceler 4.6 22 6 22 Offset	ation 1 acceleration 2 2 50 2 50 Passengers	Speed braking 1 (km/ 56 56 Showir Start	hj Command

Vehicle Create	
Name	New
Empty mass [Tn]	41.2
Rotating mass [Tn]	4
Passenger load [Tn]	13
Auxiliary power [kW]	6
Speed acceleration 1 [km/h]	20
Speed acceleration 2 [km/h]	50
Speed braking 1 [km/h]	56
Speed braking 2 [km/h]	63
Max. traction power [kW]	700
Max. braking power [kW]	1550
Max. traction current [A]	700
Max. heating power [kW]	40
HVAC percentage [%]	30
Coef. A resistance force [N/kg]	0.045
Coef. B resistance force [N/(kg m/s)]	0.0022
Coef. C resistance force [N/(m/s) ²]	0.36
Efficiency accelerating [pu]	0.81
Efficiency braking [pu]	0.81
Acceleration [m/s ²]	1.3
Braking [m/s ²]	1.2
Save	Cancel

116

INPUT DATA	A							
General p	parameters	\$	Simul	ation parameters		Conductor param	neters	
Name		New Simulation	Duration	n of the simulation [h]	3	Wear contact wire [%]		10
Email		ferran.rovira@kruch.com	Choppe	er voltage [V]	720	Wear of steel third rail	[%]	10
N°		1	Acceler	ration & braking	Maximum 🔻	Wear of the return rail	[%]	10
Priority		Low priority	✓ Stoppin	ng time at the stations	Fixed (20s) v	Temperature feeding [.°C]	70
			Investm	nent [k€]	0	Temperature OCS [°C]		50
						Temperature return ra	il [°C]	40
VEHICLES		_						REATE DELE
	Name		lotating ass [Tn]		kiliary Spe er (kW) accelera		Cf Speed braking 1 [km/h	Comman
		mass [Tn] ma		load [Tn] powe		ation 1 acceleration 2	Speed	Comman
	Name	mass [Tn] ma	ass [Tn]	load [Tn] powe	er [kW] accelera	ation 1 acceleration 2 50	Speed braking 1 [km/h	Commano
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] powe	er [kW] accelera	ation 1 acceleration 2 50	Speed braking 1 [km/h 56 56	h] Command
	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] powe	er [kW] accelera	ation 1 acceleration 2 50	Speed braking 1 [km/f 56 56 Showing	h] Comman
C .	Name Kruch1 Kruch2	mass [Tn] ma 41.7	ass [Tn] 4.17	load [Tn] powe 25 4 20 Frequency	er [kW] accelera	ation 1 acceleration 2 50	Speed braking 1 [km/f 56 56 Showing	n] Comman
	Name Kruch1 Kruch2	mass [Tn] ma 41.7 40.8	ass [Tn] 4.17 4 Units	load [Tn] powe 25 4 20 Frequency	er [kW] accelera 4.6 222 6 22	Attion 1 acceleration 2 50 50 50 Passengers	Speed braking 1 [km/ł 56 56 Showing	n] Command Command Call and Call and
TIMETABLE	Name Kruch1 Kruch2 ES	mass [Tn] ma 41.7 40.8 Vehicle	ass [Tn] 4.17 4 Units per vehicle	load [Tn] powe 25 4 20 Frequency [min]	er [kW] accelera 4.6 222 6 22 6 22 0ffset [min]	Attion 1 acceleration 2 50 2 50 Passengers per vehicle [%]	Speed braking 1 [km/ł 56 56 Showing Start time [min]	g 1 to 2 of 2 entrie

General	l parameters		Simula	tion parameters		Conductor par	ameters	
Name		New Simulation		of the simulation [h]	3	Wear contact wire		10
Email						Wear of steel third	_	
		ferran.rovira@kruch.com	Chopper voltage [V]		720			10
lo		1	Accelera	tion & braking	Maximum	 Wear of the return 	rail [%]	10
riority		Low priority	✓ Stopping	g time at the stations	Fixed (20s)	 Temperature feedir 	ig [°C]	70
			Investme	ent [k€]	0	Temperature OCS [°C]	50
						Temperature return	rail [°C]	40
		Empty F	Rotating	Passenger Auxi	iary Sj	peed Speed	Speed	
	S Name		Rotating nass [Tn]	Passenger Auxi load [Tn] power	[kW] accele	eration 1 acceleration	Speed 2 braking 1 [km/	Commands
					[kW] accele		Speed	Commande
	Name	mass [Tn] m	nass [Tn]	load [Tn] power	[kŴ] accele	eration 1 acceleration	Speed 2 braking 1 [km/	Commands
	Name Kruch1 Kruch2	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] power 25 4.1	[kŴ] accele	eration 1 acceleration 22 50	Speed 2 braking 1 [km 56 56 Showir	h] Commands
)) IMETABL	Name Kruch1 Kruch2	mass [Tn] m 41.7	ass [Tn] 4.17	load [Tn] power 25 4.1	[kŴ] accele	eration 1 acceleration 22 50	Speed 2 braking 1 [km 56 56 Showir	h] Commands
	Name Kruch1 Kruch2 ES	mass [Tn] m 41.7 40.8	nass [Tn] 4.17 4	Ioad [Tn] power 25 4: 20 6 Frequency	[kW] accele	Passengers	2 Speed 2 braking 1 [km 56 56 Showir 51	h] Commands
	Name Kruch1 Kruch2 ES Line	mass [Tn] m 41.7 40.8 Vehicle	aass [Tn] 4.17 4 Units per vehicle	Ioad [Tn] power 25 4.1 20 6 Frequency [min]	[kW] accele 5 Offset [min]	Passengers per vehicle [%]	2 Speed 2 braking 1 [km 56 56 Showin 5tart time [min]	h] Commands

Timetables _{Edit}	
Line	Line 3 🔹
Vehicle	Kruch1 +
Units per vehicle	2
Frequency [min]	15
Offset [min]	3
Passengers per vehicle [%]	100
Start time [min]	1
Save	Cancel



• Regular schedule: No football game

Name	Transformer	Positives	OC S	Rail-earth	CW	kWh/h	Investment
	loads	feeders	voltage	voltage	temperature	purchased	[k€]
Regular schedule: 10 min	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	2980	0

- Regular schedule: No football game
- Football game without investment

Name	Transformer loads	Positives feeders	OC S voltage	Rail-earth voltage	CW temperature	kWh/h purchased	Investment [k€]
Regular schedule: 10 min	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	2980	0
Football game: 2.5 min	Not acceptable	Acceptable	Not acceptable	Acceptable	Acceptable	3810 🖍	0

• 3 new substation → 3.6 M€

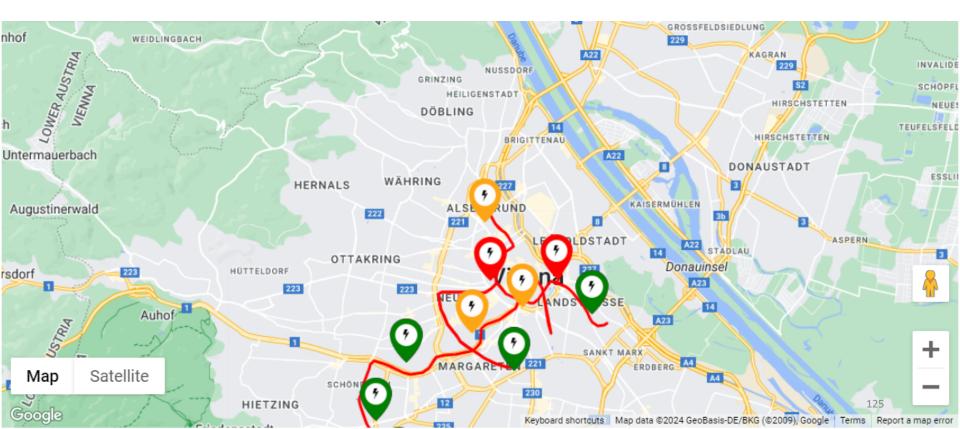


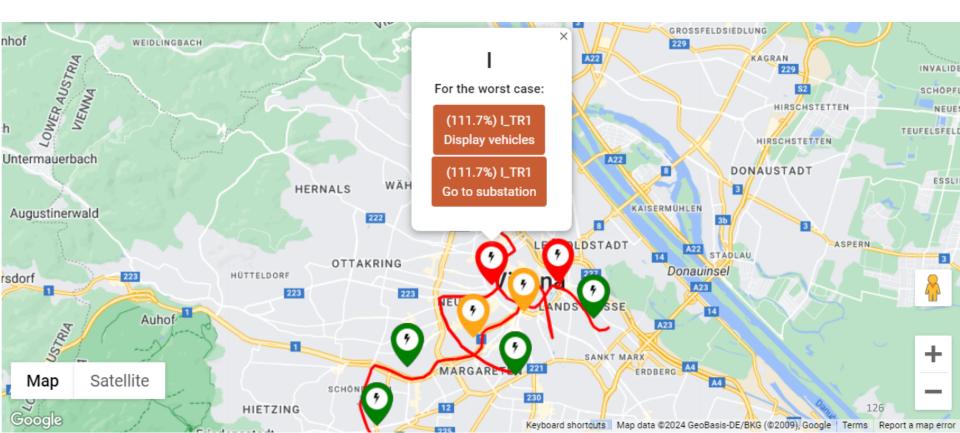
- 3 new substation → 3.6 M€
- 3 batteries (700 kWh) → 2.1 M€

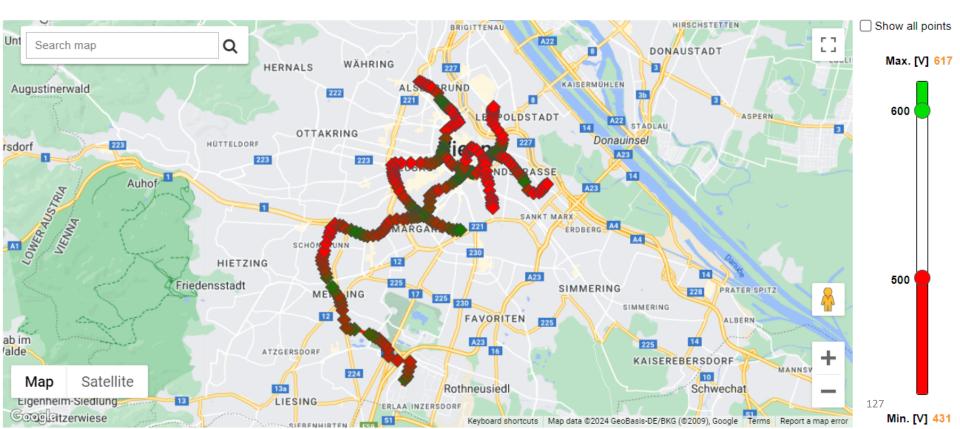
Name	Transformer loads	Positives feeders	OC S voltage	Rail-earth voltage	CW temperature	kWh/h purchased	Investment [k€]
Regular schedule: 10 min	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	2980	0
Football game: 2.5 min	Not acceptable	Acceptable	Not acceptable	Acceptable	Acceptable	3810 💽	0
Football game: 2.5 min + 3 extra subst.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	3780	3600
Football game: 2.5 min + 3 extra ESS	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	3480	2100

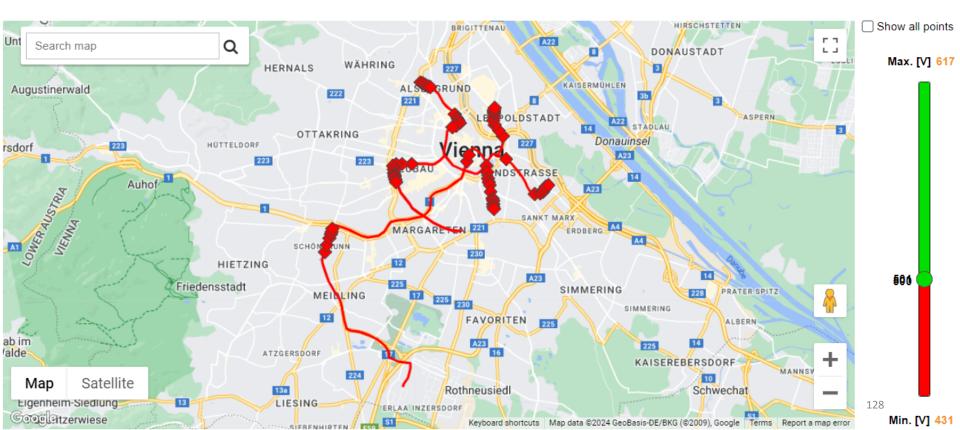
- 3 new substation → 3.6 M€
- 3 batteries (700 kWh) → 2.1 M€

Name	Transformer Ioads	Positives feeders	OC S voltage	Rail-earth voltage	CW temperature	kWh/h purchased	Investment [k€]
Regular schedule: 10 min	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	2980	0
Football game: 2.5 min	Not acceptable	Acceptable	Not acceptable	Acceptable	Acceptable	3810 💉	0
Football game: 2.5 min + 3 extra subst.	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	3780	3600
Football game: 2.5 min + 3 extra ESS	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	3480 💉	2100 💌
Football game: 4 min	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	3644	0









ld	Name	Transformer Ioads	OCS & 3rd rail voltage	Rail-earth voltage	Positives feeders	Negative feeders	Investment [k€]
39016	N scenario - 10 min - CW100	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	0

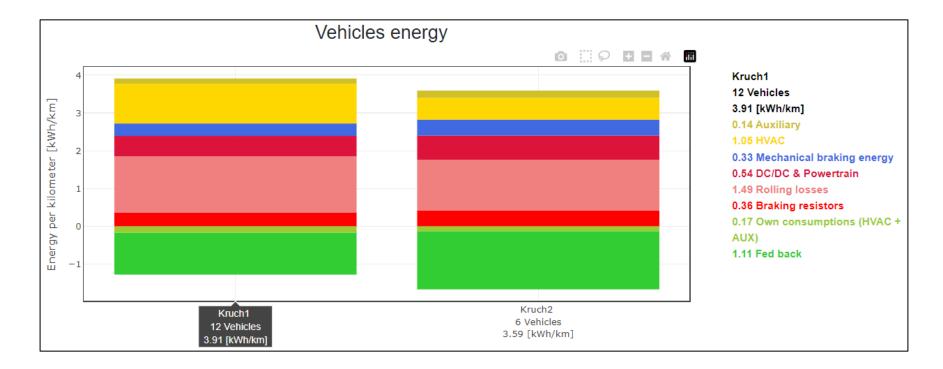
ld	Name	Transformer loads	OCS & 3rd rail voltage	Rail-earth voltage	Positives feeders	Negative feeders	Investment [k€]
39016	N scenario - 10 min - CW100	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	0
39024	N scenario - 10 min - CW100+MW150	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	1000 🖍

Id	Name	Transformer Ioads	OCS & 3rd rail voltage	Rail-earth voltage	Positives feeders	Negative feeders	Investment [k€]
39016	N scenario - 10 min - CW100	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	0
39024	N scenario - 10 min - CW100+MW150	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	1000 💉
39025	N scenario - 10 min - CW100+MW150 + I&G 2xPnominal	Acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	3000 💉

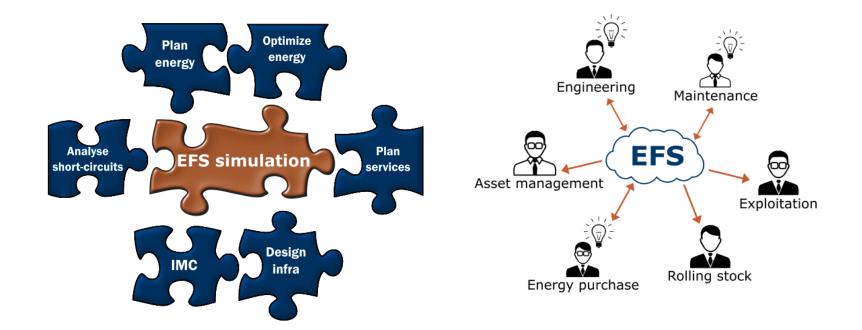
Id	Name	Transformer Ioads	OCS & 3rd rail voltage	Rail-earth voltage	Positives feeders	Negative feeders	Investment [k€]
39016	N scenario - 10 min - CW100	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	0
39024	N scenario - 10 min - CW100+MW150	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	1000
39025	N scenario - 10 min - CW100+MW150 + I&G 2xPnominal	Acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	3000
39030	N scenario - 10 min - CW100+2xMW150 + I&G 2xP nominal	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	5000

ld	Name	Transformer Ioads	OCS & 3rd rail voltage	Rail-earth voltage	Positives feeders	Negative feeders	Investment [k€]
39016	N scenario - 10 min - CW100	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	0
39024	N scenario - 10 min - CW100+MW150	Not acceptable	Not acceptable	Acceptable	Acceptable 🖋	Acceptable	1000 🖍
39025	N scenario - 10 min - CW100+MW150 + I&G 2xPnominal	Acceptable	Not acceptable	Acceptable	Acceptable	Acceptable	3000 🖉
39030	N scenario - 10 min - CW100+2xMW150 + I&G 2xP nominal	Acceptable	Acceptable	Acceptable	Acceptable 🖋	Acceptable 🖋	5000 🖍

User case 3: Energy vehicle comparison



Why a simulation tool?





Thank you for your attention

How can EFS help you?

Visit us at our booth in the exhibition hall for an EFS demonstration

Eng. Gerard Clariana <u>gerard.clariana@kruchsidos.</u>com Telf. +34 664 09 88 34