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EUROPSKI STRUKTURNI  
I INVESTICIJSKI FONDOVI



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## Measurement method of energy consumption of skidder



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## RESEARCH AIM

The main goal of the research is to develop methods for measuring the energy consumption of skidders

ie. determination of the energy consumption of the skidder at different operating tasks and under different field conditions.

It is necessary to perform field measurements on existing vehicles, then conduct an adequate analysis of the collected data which, after processing, are used as a basis for the development of hybrid drives.





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## SKIDDER TYPE AND MEASURING DEVICES

Skidder Ecotrac 140V skidder was equipped by new measurement device – WIGO-E (Telematic Data collector) gateway fuel flow meter.

Devices provided precise data collecting of technical characteristics during timber skidding at different operating tasks and under different field conditions.



## RESEARCH AREA

Bjelovar-bilogora County – timber skidding from final fellings on hilly terrains

Lika –Senj County – timber skidding selective fellings on mountainous terrains

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## MEASUREMENTS

### Mobilisis – measuring equipment (installation)

WIGO-E (Telematic Data collector) gateway

- collecting and storing data from sensors and motor computer via CANBUS
- integrated GPS system
- data transfer of WLAN, LAN and GSM communication to Web platforms (Cloud).



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## MEASUREMENTS

### Differential fuel flow meters– DFM 100 D

Model	Minimum flow rate in each measuring camera, L/h	Maximum flow rate in each measuring camera, L/h	Measurement inaccuracy, ± %
DFM 100D	10	100	3

Nominal / Max fuel pressure, MPa	0,2 / 2,5
Min / Max kinematic viscosity, mm <sup>2</sup> /s	1,5 / 6.0
Infiltrations size in the liquid, mm	0,08
Min / Max supply voltage, V	10 / 45
Max current consumption, mA, dor Unom = 12/24 V	50 / 25
Operating temperature, °C	-40 ... +85 / -20 ... +60
Ingress protection rating (IP Code)	54

Measurement precision = 0,001 L





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## MEASUREMENTS

### Remote measurements

- Fuel consumption (mL)
- Position (travelling route) of skidder (lat, lon)
- Detection of winch work (0, 1)
- Engine rpm ( $\text{min}^{-1}$ )
- Engine torque (% od max)
- Throttle position (%)
- Engine temperature
- sampling frequency – 3-5 s

### Terrain measurements

- Skidder load volumes per cycles
- Slopes of skid trails (GNSS)





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## DATA COLLECTION

- Web platform
- Mobilisis interface
- Vehicle operation reports (graphic and tabular display, .xlsx, .pdf)

The screenshot displays the Mobilisis web interface for fleet management. The main map shows a purple route with several 'stop' markers. The left sidebar contains navigation menus for 'Alati', 'Vozila', and 'Strojevi'. The 'Vozila' section lists two vehicles: '734574 EcoTrack 140' (status: Nedostupan 8h 21m) and 'Bjelovar EcoTrack 140' (status: Bez GPS jedinice). The 'Strojevi' section lists 'FORWARDER Timberjack 1710D' (status: Vozač nije prijavljen, Zaustavljen 5h 38m). The right sidebar shows a calendar and a detailed 'Info' panel for the selected vehicle, including location (Velika Plana, Gospić, Hrvatska), status (Aktivno), battery level (27.8 V), and operational metrics (4 km to last processing, 3360 h to last processing). A legend at the bottom of the map defines the route colors: grey for engine inactive, purple for engine active, blue for left turn, and red for right turn.

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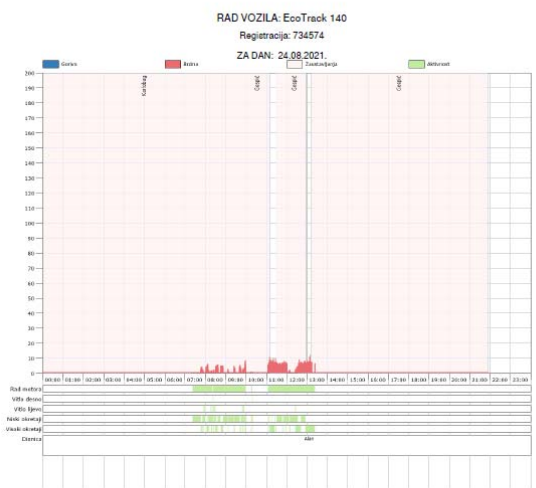
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MOBILISIS®

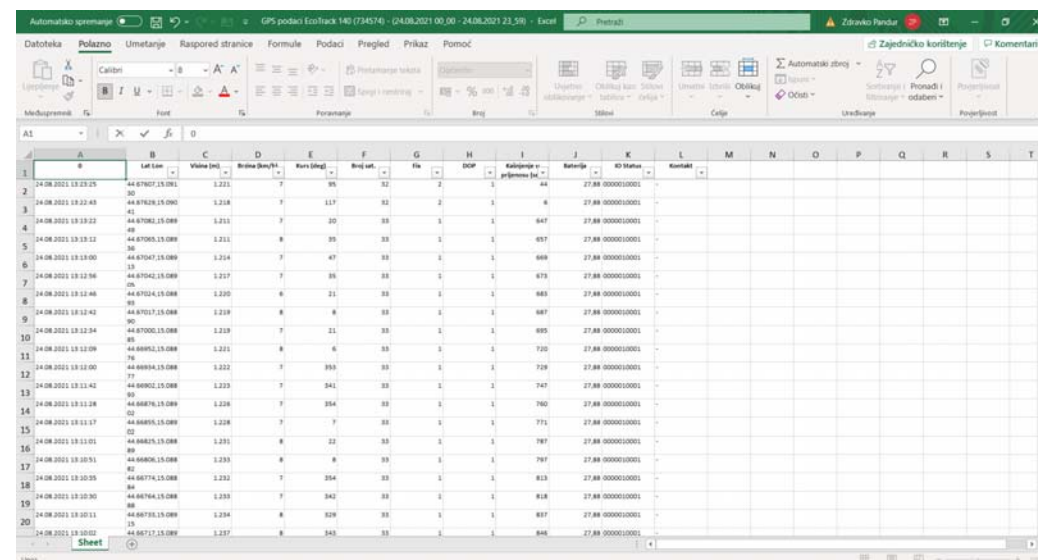


Rad

	Pozivak	Kraj	Radni sati	Apsolutna vrijeme	Udaljenost
Vožnja	09:57	13:13	00:37	03:14	5 km
Rad motornje	07:22	13:23	06:00	08:01	5 km
Više držanje	08:22	10:17	00:00	01:55	0 km
Više čišćenje	07:52	10:26	00:00	04:32	0 km
Niški okretaji	07:22	10:54	00:29	06:32	0 km
Višak okretaji	07:47	13:23	01:38	05:38	4 km

24.8.2021. 21:53:32

1.



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## DATA PROCESSING

- Merging all data into a database

Mjerač protoka goriva | Bjelovar (EcoTrack 140) | 10.02.2022

**MOBILISIS®** Mobilisis d.o.o.  
Varaždinska ul. 8, 42000, Jalkovec  
042 311 777  
www.mobilisis.hr

Datum	Temperatura zraka (°C)	Wind speed (km/h)	Humidity (%)	Ukupna potrošnja goriva (L/h)	Potrošnja goriva na snagu (L/h)	Potrošnja goriva na vuču (L/h)	Potrošnja goriva na rad (L/h)	Potrošnja goriva na pripremu (L/h)	Vrijeme rada motora (h:min)	Vrijeme rada motora s punom opterećenjem (h:min)	Vrijeme rada motora s malom opterećenjem (h:min)	Vrijeme rada motora s punom opterećenjem (h:min)	Vrijeme rada motora s malom opterećenjem (h:min)
10.02.2022 6:56	47	0	0,02	510,758	67,978	430,585	32,195	4,015	56:04	32:16	23:35	00:00	00:02
10.02.2022 6:56	-2	1	0,03	510,838	68,028	430,615	32,195	4,015	56:05	32:17	23:35	00:00	00:02
10.02.2022 6:56	-2	0	0,04	510,858	68,043	430,62	32,195	4,015	56:06	32:18	23:35	00:00	00:02
10.02.2022 6:56	-1	1	0,16	510,908	68,078	430,635	32,195	4,015	56:06	32:18	23:35	00:00	00:02

FMS podaci | Bjelovar (EcoTrack 140) | 10.02.2022 00:00 - 23:59

**MOBILISIS®** Mobilisis d.o.o.  
Varaždinska ul. 8, 42000, Jalkovec  
042 311 777  
www.mobilisis.hr

Vrijeme	Starije broj čamca (°)	Brzina (km/h)	Ukupna potrošnja goriva (L/h)	Količina goriva u spremniku (L)	Razina goriva (%)	Radnih sati (h:min)	Dvoj. obrtaja motora (RPM)	Obrtajni moment (% od maksimalnog) (Nm)	Protokla papučiće (g/s)	Temperatura motora (°C)	Stajanje s upaljenim motorom (h:min)	Dvoj. potrošnja (L/h)	Dvoj. potrošnja (L/h)
10.02.2022 14:44:58			7.651,0			785,30	748	14			00:00		
10.02.2022 14:44:53			7.651,0			785,30	1.800	15	58		00:00		
10.02.2022 14:44:48			7.651,0			785,30	1.285	71	48		00:00		
10.02.2022 14:44:43			7.651,0			785,30	1.127	0	4		00:00		

broj	visina	x	y	razmak po x osi	razmak po y osi	horizontalan razmak	stacionaža, m	Stvaran razmak n	visine	nagib u	nagib kretanja u stupnjem	prazan	tovar, r	vremena
15	154,336		526881,818		225,18	276,46	22,40	0,00	22,52	154,34	-10,51%	-6,00 pun	4,96	8:03:33 početak
14	151,982		526896,824		37,03	115,69	12,36	22,40	12,49	151,98	-14,68%	-8,35 pun	4,96	8:03:44
13	150,168		526902,909		176,31	559,28	27,12	34,76	27,22	150,17	-8,41%	-4,81 pun	4,96	8:03:51
12	147,888		526916,187		361,91	1329,33	41,12	61,88	41,42	147,89	-11,96%	-6,82 pun	4,96	8:04:04
11	142,970		526935,211		66,39	489,34	23,57	103,00	23,84	142,97	-14,97%	-8,52 pun	4,96	8:04:33
10	139,440		526943,359		11,53	669,83	26,10	126,58	26,40	139,44	-15,14%	-8,61 pun	4,96	8:04:45
9	135,487		526946,755		48,16	1560,25	40,11	152,68	40,16	135,49	-5,14%	-2,94 pun	4,96	8:05:00
8	133,427		526953,695		223,53	867,07	33,02	192,78	33,05	133,43	-4,09%	-2,34 pun	4,96	8:05:26
7	132,076		526968,646		35,25	534,63	23,87	225,81	23,88	132,08	-2,30%	-1,32 pun	4,96	8:05:50
6	131,528		526974,583		0,03	258,82	16,09	249,68	16,09	131,53	-2,64%	-1,51 pun	4,96	8:06:00
5	131,104		526974,755		22,94	848,62	29,52	265,77	29,55	131,10	-4,38%	-2,51 pun	4,96	8:06:11
4	129,810		526969,965		60,23	477,42	23,19	295,29	23,20	129,81	-3,79%	-2,17 pun	4,96	8:06:29
3	128,932		526962,204		4,61	212,90	14,75	318,48	14,76	128,93	-4,45%	-2,55 pun	4,96	8:06:56
2	128,275		526960,058		9,71	335,37	18,58	333,23	18,60	128,28	-4,60%	-2,63 pun	4,96	8:07:06
1	127,421		526963,174					351,80		127,42			4,96	8:07:22 kraj

Radilište	Datum	Vrijeme turnusa	Broj turnusa	Broj komada u tovaru	Vrsta drveta	Promjer (cm)	Duljina (m)	Obujam (m³)
Dišnica - Zobikovac - Petkovača 10c	10.2.2022	7:00	1		Bukva	50	6	1,1775
Dišnica - Zobikovac - Petkovača 10c	10.2.2022		1		Bukva	52	7	1,485848
Dišnica - Zobikovac - Petkovača 10c	10.2.2022		1		Bukva	44	6,4	0,972646
Dišnica - Zobikovac - Petkovača 10c	10.2.2022		1		Bukva	45	5,4	0,858398
Dišnica - Zobikovac - Petkovača 10c	10.2.2022	8:10	1	5	Bukva	43	3,2	0,464469

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Datum	Turnus	Radni zahvat	Potrošnja goriva, L	Potrošnja energije, kWh	Potrošnja goriva po turnusu, L	Potrošnja energije po turnusu, kWh	Privučeni tovar, m <sup>3</sup>
28.4.2022	1	Prazan	2,66	29,15	5,94	65,048	1,82
28.4.2022	1	Privitlavanje	0,83	9,10			
28.4.2022	1	Pun	1,87	20,50			
28.4.2022	1	Stovarište	0,575	6,30			
28.4.2022	2	Prazan	2,87	31,46	5,85	64,171	3,91
28.4.2022	2	Privitlavanje	1,275	13,97			
28.4.2022	2	Pun	1,005	11,01			
28.4.2022	2	Stovarište	0,705	7,73			
28.4.2022	3	Prazan	2,915	31,95	5,85	64,116	2,28
28.4.2022	3	Privitlavanje	1,43	15,67			
28.4.2022	3	Pun	0,95	10,41			
28.4.2022	3	Stovarište	0,555	6,08			
28.4.2022	4	Prazan	2,74	30,03	6,32	69,322	2,46
28.4.2022	4	Privitlavanje	0,995	10,91			
28.4.2022	4	Pun	1,545	16,93			
28.4.2022	4	Stovarište	1,045	11,45			
28.4.2022	5	Prazan	3,195	35,02	5,11	56,006	1,98
28.4.2022	5	Privitlavanje	0,565	6,19			
28.4.2022	5	Pun	0,445	4,88			
28.4.2022	5	Stovarište	0,905	9,92			
28.4.2022	6	Prazan	2,075	22,74	4,19	45,977	2,57
28.4.2022	6	Privitlavanje	0,72	7,89			
28.4.2022	6	Pun	0,98	10,74			
28.4.2022	6	Stovarište	0,42	4,60			
28.4.2022	7	Prazan	2,17	23,78	5,19	56,937	2,5
28.4.2022	7	Privitlavanje	1,22	13,37			
28.4.2022	7	Pun	0,92	10,08			
28.4.2022	7	Stovarište	0,885	9,70			



Skid trail length: 896 m

Skid trail average slope: + 8 %

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## CONCLUSIONS

The development of methods for the determination of the energy consumption of different types of forest vehicles performing different work tasks under different terrain conditions is a very important topic of scientific research in the field of forestry engineering. These data could be used as a basis for the development of hybrid and electric forest vehicles.

The new measurement method indicates the high accuracy of measuring data and could be considered a favorable tool for remote monitoring of operational characteristics of skidder in uncontrolled conditions for scientific research.



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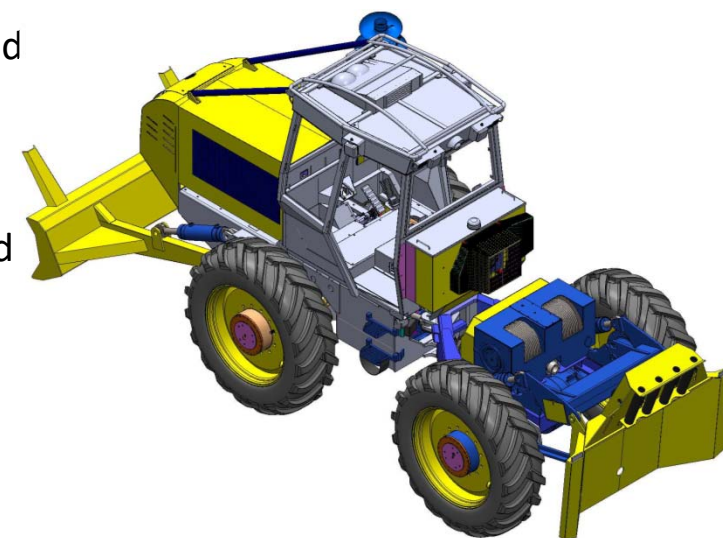
HiSkid

## ACKNOWLEDGMENTS

This research was co-funded by the European Regional Development Fund, in the scope of the European Union Operational Programme «Competitiveness and Cohesion» under the grant KK.01.1.1.04.0010 (Development of hybrid skidder—HiSkid).

The project is implemented in partnership between the Faculty of Forestry and Wood Technology and the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb.

The final outcome of the project is the conceptual design of a hybrid skidder that will be the basis for the prototype.





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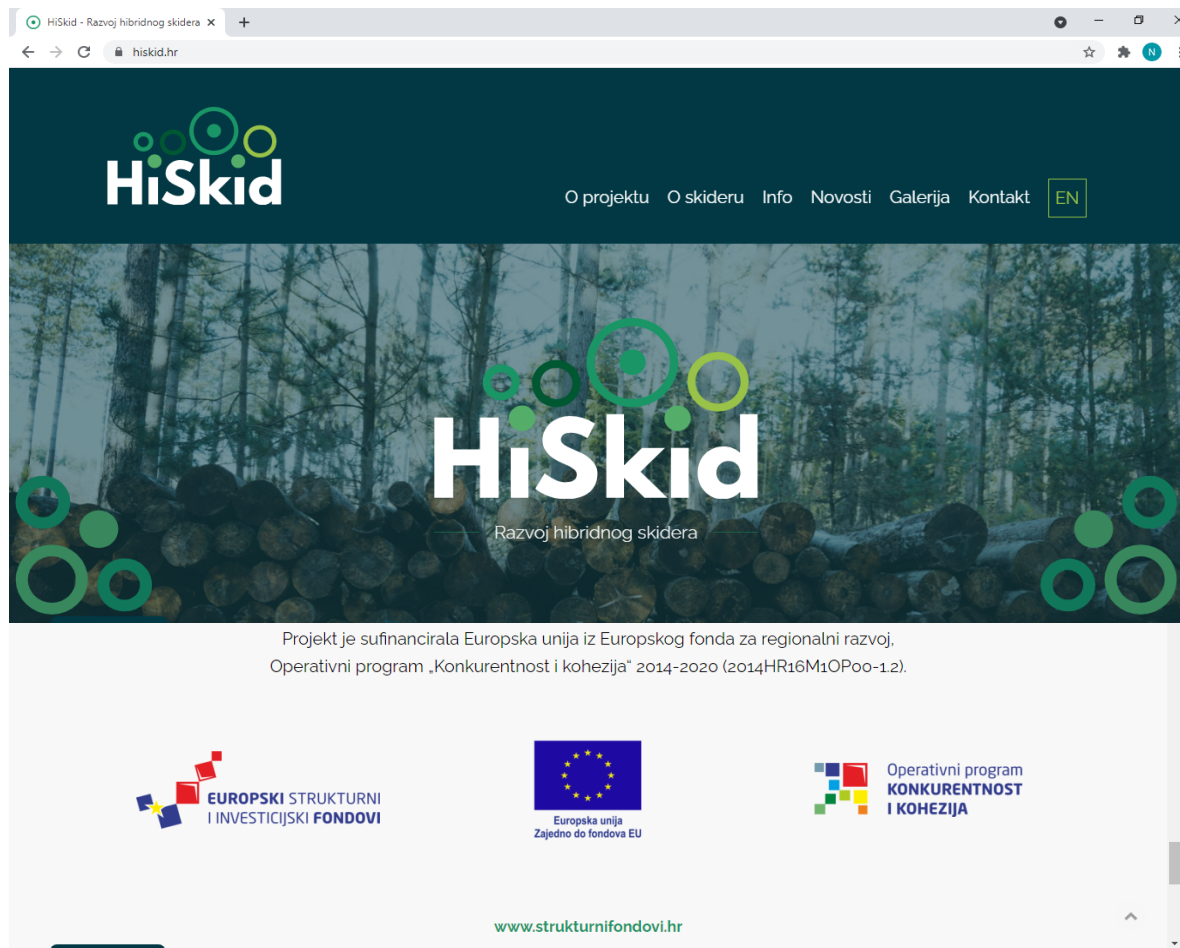


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# HiSkid

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**THANK YOU FOR ATTENTION!**



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