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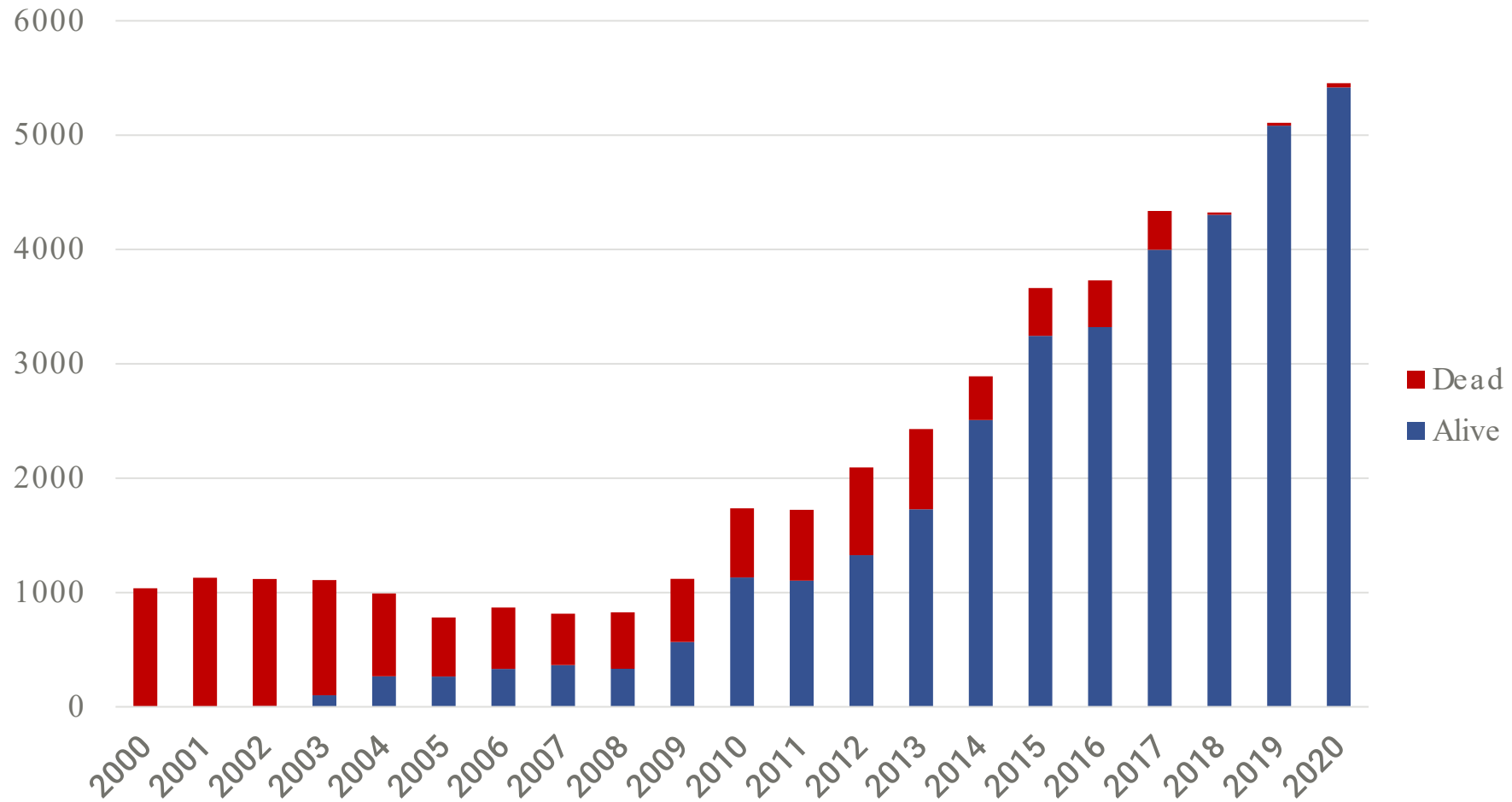
Albuquerque | Boise | Dallas | Denver | Las Vegas | Los Angeles | Los Cabos | Orange County | Phoenix |
Portland | Reno | Salt Lake City | San Diego | Seattle | Tucson | Washington, D.C.

We Understand Batteries.

- Full-service law firm
- Our clients include battery innovators and battery integrators (e.g., auto manufacturers)
- 40+ IP attorneys
- Battery materials, cells, modules, thermal systems, battery management systems

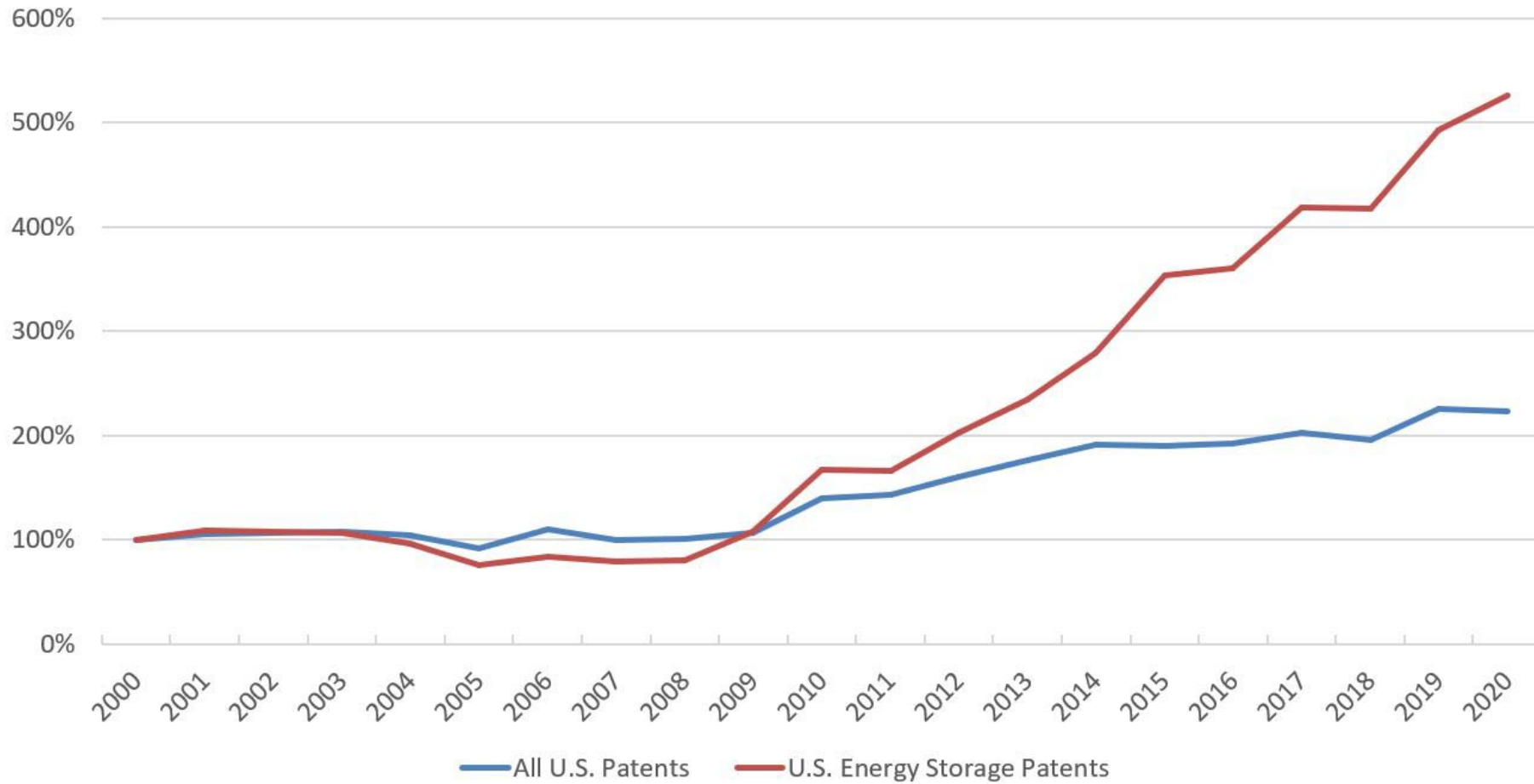
Trends in U.S. Energy Storage Innovation

Energy Storage U.S. Granted Patents, 2000-2020



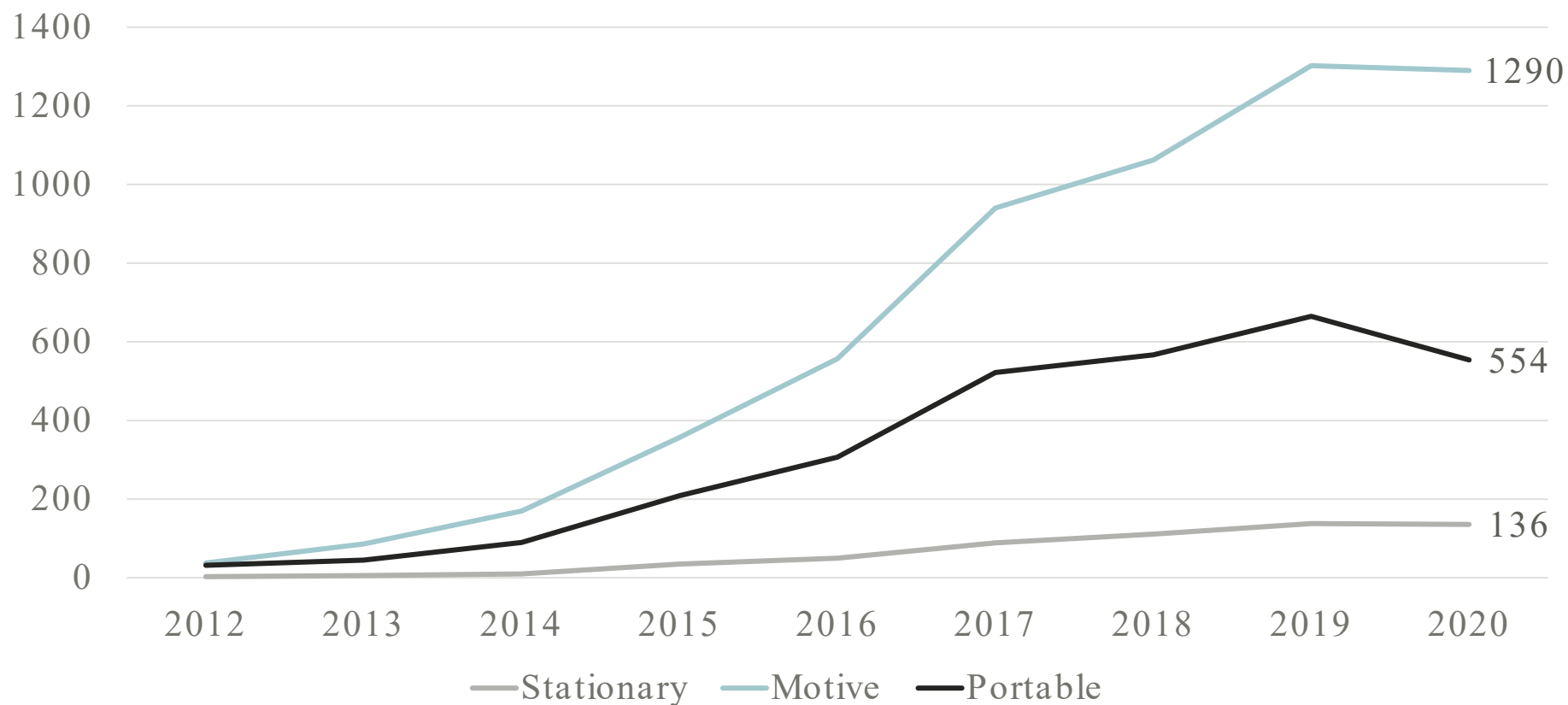
Trends in U.S. Energy Storage Innovation

U.S. Granted Patents 2000-2020, Percent increase over time



Trends in U.S. Energy Storage Innovation

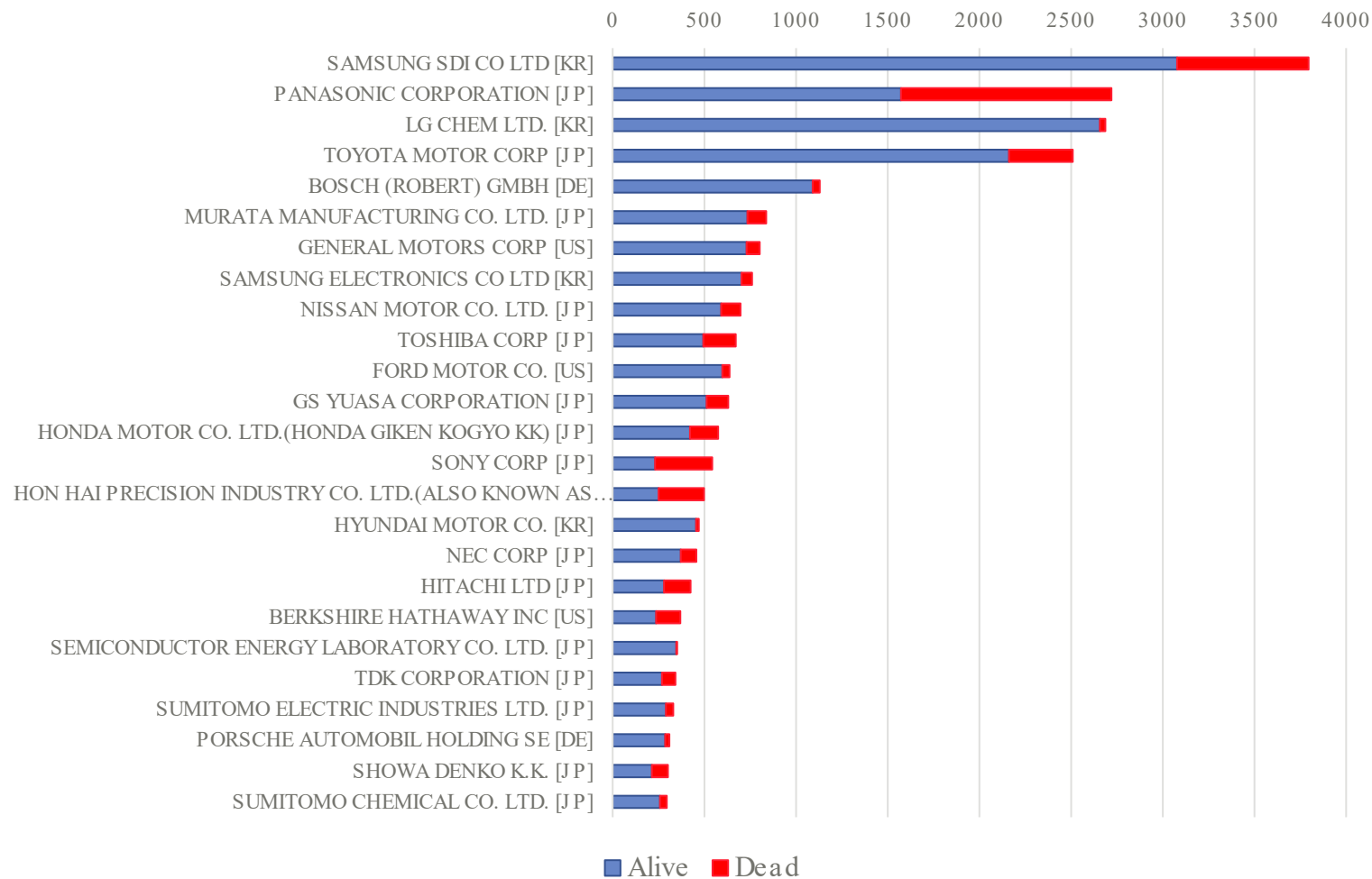
US Granted Patents, End Use of Battery Technology, Patent Count vs. Publication Year



* Prior to 2013 the US patents were classified using a different system (USPC vs. today's CPC).

Trends in Energy Storage Innovation

U.S. Granted Patents, Top Assignees vs. Patent status



Trends in Energy Storage Innovation

US Granted Patents, Top Assignees vs Grant Year

SAMSUNG	8	32	30	37	28	40	57	56	126	259	287	253	348	515	595	473	438	370	407	343
TOYOTA MOTOR	25	38	56	48	40	41	32	41	63	99	140	258	236	280	247	214	281	345	374	408
LG CHEM	0	4	3	8	5	2	13	9	57	69	77	68	110	159	253	209	269	260	344	475
PANASONIC	75	64	93	81	62	69	48	82	92	146	120	181	124	107	103	119	93	107	99	148
HONDA MOTOR	24	27	50	68	67	90	76	73	74	127	91	107	75	91	98	102	94	88	108	108
GM GLOBAL	11	27	31	35	37	28	45	58	66	138	145	123	207	175	175	133	92	65	102	76
SANYO ELECTRIC	39	57	50	43	34	24	32	34	35	55	45	78	62	33	38	40	52	48	72	42
ROBERT BOSCH	0	0	7	1	9	6	6	7	13	21	15	32	73	134	169	140	151	96	131	93
HYUNDAI MOTOR	3	4	1	4	5	8	4	3	6	18	17	27	36	58	64	103	97	130	153	153
TOSHIBA	10	17	13	17	14	18	16	16	32	45	42	43	48	37	33	52	57	48	80	65
NISSAN MOTOR	5	11	22	22	26	36	38	31	36	39	35	41	48	58	61	79	102	76	111	69
MURATA MANUFACTURING	21	20	13	17	7	29	22	18	21	48	26	34	27	73	93	67	103	80	67	69
SONY	15	20	22	32	15	37	33	28	39	48	35	42	48	30	21	17	23	16	9	14
KIA MOTORS	0	0	0	0	0	2	0	0	2	3	3	11	14	22	30	22	23	25	72	127
FORD GLOBAL	8	7	4	6	5	6	4	2	5	5	6	12	13	18	35	77	99	87	110	115
GS YUASA INTERNATIONAL	15	15	13	9	5	8	3	4	11	7	13	14	13	25	60	62	64	80	60	61
GENERAL ELECTRIC	5	1	9	8	11	13	7	7	16	21	18	20	14	17	25	8	16	15	12	8
COMMISSARIAT AL ENERGIE ATOMIQUE	1	2	2	0	0	2	7	3	10	23	19	22	28	33	43	39	38	43	50	40
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

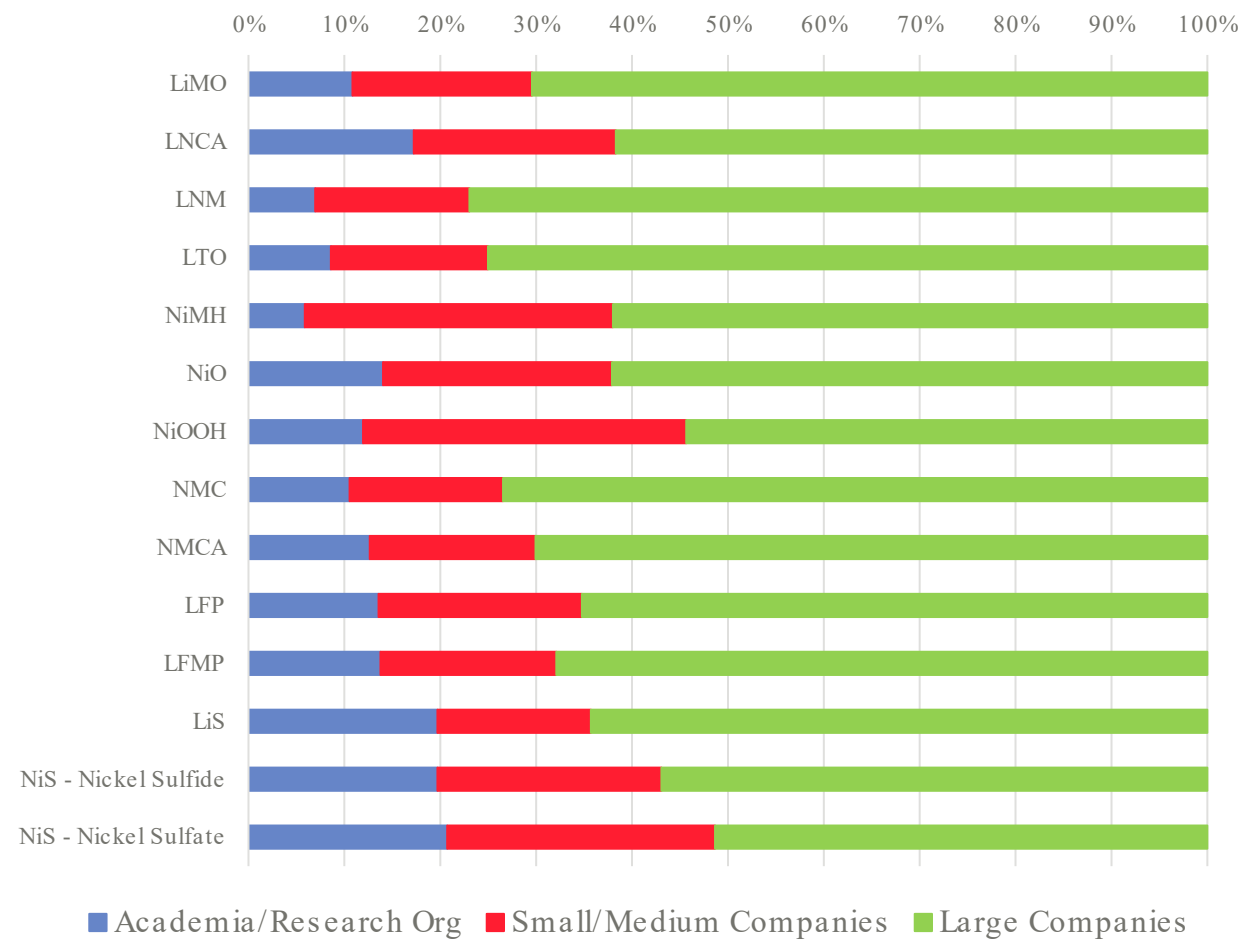
Trends in Energy Storage Innovation

US Granted Patents, Earliest Priority Country vs. Grant Year

US	808	766	857	818	734	735	695	684	833	1172	1153	1191	1312	1477	1647	1606	1734	1729	1923	2109
JP	477	604	601	611	488	587	536	574	700	1009	944	1286	1154	1219	1351	1420	1606	1631	1866	1880
KR	36	55	46	52	50	62	81	86	194	367	400	388	507	700	871	747	841	847	1011	1086
DE	75	86	116	109	84	81	70	87	76	119	98	98	114	127	176	186	273	224	267	317
CN	3	2	3	5	1	4	4	7	17	35	57	130	104	91	112	100	130	138	206	309
WO	12	13	16	19	15	16	15	9	15	23	30	66	115	170	183	205	253	218	229	213
FR	28	38	15	17	9	10	20	18	24	51	48	50	62	77	96	95	101	98	111	78
GB	16	23	27	13	15	14	20	25	19	26	25	31	33	32	41	43	73	55	81	59
EP	16	18	12	15	16	19	11	24	15	33	30	34	46	57	62	58	86	88	118	116
TW	9	8	11	16	16	19	20	17	33	41	44	60	56	49	63	62	34	41	58	78
IT	3	5	8	6	6	6	5	8	5	10	12	10	9	14	15	13	10	14	7	11
CA	10	12	13	13	15	7	14	8	7	8	8	9	5	8	3	11	8	7	6	5
SE	9	3	6	4	3	4	2	3	3	4	2	1	2	4	2	4	4	2	3	9
AU	3	4	6	7	4	6	3	6	6	4	8	3	3	2	6	2	5	7	5	10
AT	0	1	1	3	1	1	0	2	2	0	1	5	3	6	5	4	3	4	8	3
NL	3	4	3	4	2	1	3	1	1	3	0	0	0	3	2	1	3	2	3	1
IN	0	0	0	0	0	0	0	0	0	1	0	0	2	2	7	5	7	12	14	8
DK	5	3	0	2	2	0	1	1	4	3	2	7	4	4	4	1	1	0	1	2
IL	3	4	0	1	1	1	0	1	4	2	0	0	3	1	0	1	2	1	1	3
ES	1	2	1	1	1	1	1	0	1	0	0	0	2	2	1	0	0	1	3	1
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

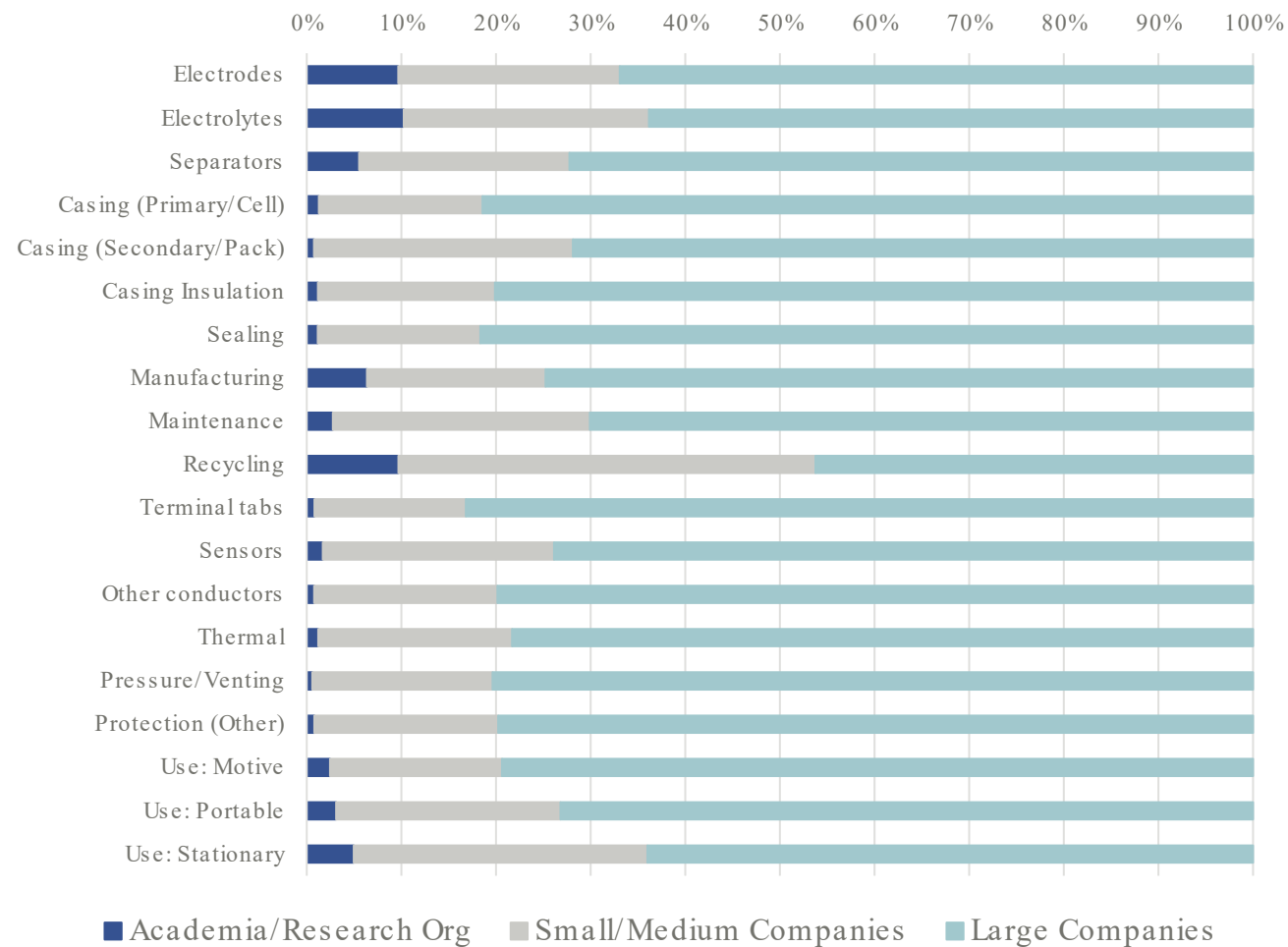
Trends in Energy Storage Innovation

US Granted Patents, Electrode Chemistry vs. Assignee Type



Trends in Energy Storage Innovation

US Granted Patents, Technical Category vs. Assignee Type



Trends in Energy Storage Innovation

US Granted Patents, Top Assignees vs. Technical Category

Assignee	Materials/ Chemistry			Casing				Life Cycle			Integrated Electronics			Protection			End Use			
	Electrodes	Electrolytes	Separators	Casing (Primary/Cell)	Casing (Secondary/Pack)	Insulation	Sealing	Manufacturing	Maintenance	Recycling	Terminal tabs	Sensors	Other Conductors	Thermal	Ventilation	Other	Motive	Portable	Stationary	Grand Total
SAMSUNG SDI CO LTD	2069	560	331	1185	676	29	218	1491	1007		820	613	1455	440	362	397	351	289	24	12317
LG CHEM LTD.	1708	503	318	591	725	65	122	1123	813	2	337	494	705	436	146	186	625	326	144	9369
PANASONIC CORPORATION	1793	583	220	452	367	35	106	972	693	7	240	343	551	207	185	123	190	77	14	7158
TOYOTA MOTOR CORP	1533	677	160	264	351	25	73	861	742	27	155	419	362	305	127	68	533	41	1	6724
BOSCH (ROBERT) GMBH	463	113	76	280	342	29	43	319	394	3	207	297	398	222	138	115	261	40	10	3750
MURATA MANUFACTURING CO. LTD.	697	368	125	174	103	4	29	394	280	1	95	122	148	45	19	23	140	133	58	2958
TOSHIBA CORP	544	191	70	100	127	3	19	212	223	4	59	93	123	42	18	19	153	16	9	2025
GS YUASA CORPORATION	378	70	79	161	117	11	29	231	157		115	92	217	55	38	29	131	12	7	1929
NISSAN MOTOR CO. LTD.	433	111	86	104	118	3	30	256	171	1	70	102	118	65	22	20	173	6	2	1891
GENERAL MOTORS CORP	423	115	76	26	107	22	3	163	260	3	21	148	88	165	3	11	206	13	4	1857
FORD MOTOR CO.	114	34	24	36	265	31	4	66	221		41	141	104	257	30	15	419	2	1	1805
SAMSUNG ELECTRONICS CO LTD	486	222	69	52	81		17	212	220		20	93	37	19	5	6	51	91	4	1685
SONY CORP	259	130	25	107	162	1	6	118	272		102	114	144	23	12	46	29	97	10	1657
NEC CORP	316	120	28	82	41		28	164	149	1	45	65	76	17	23	9	60	26	10	1260
CPS TECHNOLOGY HOLDINGS LLC	143	14	22	64	114	18	6	79	121	9	67	95	102	71	52	32	157		11	1177
HONDA MOTOR CO. LTD.(HONDA GIKEN KOGYO	195	92	7	29	191	4	8	47	137	1	19	78	69	106	9	7	141	6	1	1147
HYUNDAI MOTOR CO.	198	71	24	39	69	11	3	76	128		26	78	57	116	25	23	168	4	2	1118
HITACHI LTD	241	56	12	37	52	6	4	80	176	4	25	130	68	32	22	9	81	5	4	1044
CONTEMPORARY AMPEREX TECHNOLOGY LTD	115	25	11	86	94	7	21	97	74		63	82	106	53	54	21	92	6	5	1012
SEMICONDUCTOR ENERGY LABORATORY CO. LT	292	71	35	57	18		4	213	86	1	19	13	25	7	3	2	50	104	3	1003
SUMITOMO ELECTRIC INDUSTRIES LTD.	111	65	13	29	116	4	7	49	102		59	85	165	31	5	39	114	3	5	1002
TDK CORPORATION	273	63	42	57	28	4	11	145	74		38	27	68	17	11	13	9	16	1	897
YAZAKI CORPORATION	13	1	1	17	115	2		10	137		54	134	198	21	5	30	112	4	1	855

Trends in Energy Storage Innovation

US Granted Patents, Top Assignees vs. Electrode Chemistry

Assignee	Oxides									Phosphates		Sulfates			Grand Total
	LMO	LNCA	LMN	LTO	NiMH	NiO	NiOOH	NMC	NMCA	LFP	LFMP	LiS	NiS	NiSO4H2O6	
LG CHEM LTD.	150	2	16	137	3	95		154	15	141	3	39	1	8	764
TOSHIBA CORP	94	6	21	203	2	31	2	62	2	34	20	4	5	1	487
SAMSUNG SDI CO LTD	95	24	12	52	2	44		71	28	52	12	29	9	6	436
GLOBAL GRAPHENE GROUP INC	45		3	55		46		41	59	40	40	83	1	7	420
PANASONIC CORPORATION	69	9	15	27	33	44	12	50	2	11		1	6	5	284
NANOTEK INSTR INC	29		2	36	1	30		25	30	28	28	41	1	3	254
BOSCH (ROBERT) GMBH	30	26	1	27		3		11	20	31	2	38	1		190
TOYOTA MOTOR CORP	41		16	18	13	11	1	49	1	24	2	7	2		185
MURATA MANUFACTURING CO. LTD.	40		8	19	2	9		29	17	19	2	9	4		158
GENERAL MOTORS CORP	27	2	1	20	3	9	1	24	3	19	8	24	3	4	148
SAMSUNG ELECTRONICS CO LTD	21	3	2	21	1	35		17	10	19	4	8	5		146
HON HAI PRECISION INDUSTRY CO. LTD.(ALSO KN	18		2	15		19	1	13	5	27	8	12	1	2	123
TSINGHUA UNIVERSITY	17		2	17		15		11	3	27	8	15	1	2	118
SEMICONDUCTOR ENERGY LABORATORY CO. LTD	18		3	4		7		24	1	35	6	1	1	1	101
UNIVERSITY OF CHICAGO	36		1	4		6		8		13	1	18	2	1	90
COMMISSARIAT A L'ENERGIE ATOMIQUE	17	3	3	14		7	1	4	1	28		9	2		89
CPS TECHNOLOGY HOLDINGS LLC	17	9	1	17	9			13	6	9	1				82
WANZIANG GROUP	17	3		9		7		11		31	3				81
NISSAN MOTOR CO. LTD.	34	1	2	1		2		31	1	2		6			80
TORAY INDUSTRIES INC.	1			34		34		6		4					79
SUMITOMO METAL MINING CO. LTD.	19	2	6	1	2	8	6	20				1	3	6	74
GREATBATCH LTD. (NEW YORK CORPORATION)	16					25		33							74
MITSUBISHI CHEMICAL HOLDINGS CORP.	15		3	19		5		27		1		2			72

Filing Trends from the US

- Takeaways
 - White Space
 - Recycling and any thing that is not Li-Ion
 - And Non Li-Ion is popular for filing in the US
 - Non-motive applications – stationary
 - Large companies v. small companies
 - Levelling bets between NMC and LFP
 - Ever increasing filings in the US that were invented outside the US
 - The 5x increase in patent filings in the last decade is does not show signs of slowing down

IP and Opportunities in the Batteries Space

- Gaps in the battery innovation
 - Recycling of battery materials
 - Thermal management
 - Alternative battery chemistries
- Evolving regulations
 - As batteries become even more ubiquitous, more rules will be created
 - If one can innovate in directions that align with regulatory aims, protecting such positions is extremely value
 - Patent the standards!

IP and Opportunities in the Batteries Space

- Target markets
 - The greatest patent filing activity in Europe is happening in Germany, France, Austria, UK and Italy. The US is clearly of interest to Asia and other countries of origin.
 - Therefore, if you aren't filing or acting in these territories, should you be?
- Not just a game for big players
 - The patent filing behaviour shows a surprisingly high number of filings from the University and SME sectors, as well as the big players
 - If an SME can create a thorny patent portfolio, there is ample scope for a range of exit strategies