Solar Energy Technology Inventive Energy

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Solar Energy Technology INVENTIVE ENERGY 2018

INTERNATIONAL PATENT CLASSES (IPC): Solar Energy Technology

IPC Domain	Description
H01M10/46	Accumulators structurally combined with charging apparatus with solar battery as charging system
H02J3/38	Maximum power point tracking control for photovoltaic sources
G01S3/78	Solar tracking systems
H02S20/32	Supporting structures being movable or adjustable, e.g. for angle adjustment specially adapted for solar tracking
G01S3/783	Systems for determining direction or deviation from predetermined direction using amplitude comparison of signals derived from static detectors or detector systems
H02S10/12	Hybrid wind-PV energy systems
H02S30/20	Collapsible or foldable PV modules
F24S20/20	Solar heat collectors for receiving concentrated solar energy, e.g. receivers for solar power plants
F24S40/53	Safety or protection arrangements of solar heat collectors; Preventing malfunction of solar heat collectors by venting solar heat collector enclosures
F24S40/57	Preventing overpressure in solar heat collector enclosures by venting

Solar energy has the potential to provide solutions to the longstanding energy problems being faced by the world. Solar energy technology is constantly-improving which lead to the development of the various solar energy systems. These solar systems are installed on the rooftops of the residential buildings. Businesses are also opting to install solar panels to offset their energy costs. Energy providers are also installing large solar power plants to provide cleaner energy to all the customers connected to the grid. Typically, there are two types of solar energy technologies—photovoltaic (PV) and concentrating solar power (CSP). The PV technology is utilized in panels. When the sun shines onto a solar panel, photons from the sunlight are absorbed by the cells in the panel, which creates an electric field across the layers and causes electricity to flow. The CSP technology concentrates the solar power that uses mirrors to reflect and concentrate sunlight onto receivers that collect solar energy and convert it to heat, which can then be used to produce electricity.

S.No	IPC Domain	Year							
1	H01M10/46	2010	2011	2012	2013	2014	2015	2016	2017
	Application	139	266	335	349	362	408	542	656
	Granted	891	1006	1121	1238	1351	1513	1709	1909
2	H02J3/38	2010	2011	2012	2013	2014	2015	2016	2017
	Application	71	100	121	143	160	251	590	1065
	Granted	248	272	294	302	322	506	897	1386
3	H02S20/32	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	2	2	3	5	10
	Granted	1054	1054	1055	1056	1056	1059	1065	1075
4	G01S3/783	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	30	92	162
	Granted	1	1	1	1	1	2	7	46
5	H02S10/12	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	1	2	3
	Granted	106	106	106	106	107	111	121	129
6	H02S30/20	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	1	4	9
	Granted	1	1	1	1	1	1	1	1
7	F24S20/20	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	13	28	28	29
	Granted	1	1	1	1	1	1	36	69
8	F24S40/53	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	1	1	1
	Granted	1	1	1	1	1	1	1	1
9	F24S40/53	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	1	1	1
	Granted	1	1	1	1	1	1	1	1
10	F24S40/57	2010	2011	2012	2013	2014	2015	2016	2017
	Application	1	1	1	1	1	1	1	1
	Granted	1	1	1	1	1	1	1	1

We identified following top 10 International Patent Classification (IPC) in the solar energy technology domain through the study of key patents. The overall number of Applications published in the United States Patent and Trademark Office (USPTO) and Patents granted by USPTO are given in the table below (from the year 2010 till 2017. These are total numbers granted and published by the world at large at USPTO in that specific year.

STATE OF ART OF ANY TECHNOLOGY USING CRAFITTI's INVENTIVE ENERGY

Inventive Energy (IE) is a yearly metric of the trend of last five years of invention activity in the specific technological domain such as the solar energy technology calculated based on a number of patent applications published and a number of patents granted in the respective technological domain. **Inventive energy is a composite metric of two indices – Patent Intensity Index and Patent Activity Index.**

CRAFITTI's **INVENTIVE ENERGY** measures the pace and intensity of **inventive activity** in a particular technological field. Inventive Energy provides a true picture of the state of the art of technology as it is a **composite metric** of Patents Granted and Patent Applications published in specific technology domains annually for a period of five years.

Inventive Energy *in specific technology domains can be utilized by existing technology players, start-ups, new players, investors, VCs, Research and Development teams and technology and Product Strategy Teams to design more informed future.*

Patent Intensity Index of a year is measured in terms of the yearly average of a number of total patents granted and patent applications published in last 5 years. *As an analogy, the Patent Intensity Index is denoted as the Mass which is reflected as a number of Patents and Applications granted and published respectively in the preceding 5 years.*

Patent Activity Index is measured in terms of the yearly average of *relative* pace of patent applications and granted patents in the IPC domain. *As an analogy, the Patent Activity Index denotes the Velocity or relative pace of Patents and Applications, granted and published respectively in the preceding 5 years, with higher weightage assigned to recent years.*

For any year, the two indices include a measure of yearly averages of last five years of a number of applications published and patents granted. For example, for 2017, these indices use data from years 2013-2017.

Patent Activity Index of top 10 solar energy technology IPC classes for years 2014-2017

A value of **Patent Activity Index** *is less than 1.0 indicates that relative average number of applications filing is reducing compared to a number of patents being granted.* **The index also gives a red, amber and green signal.** Red indicates the value of the index is less than 1.0. Amber indicates it is between 1.0 and 2.0 and green indicates it is above 2.0, i.e., *the number of applications being published every year on an average is more than 2 times the number of patents being granted on an average*. A higher value of patent activity index is an indication of more recent inventive activity in the domain or the specific IPC class. In turn, a higher activity index will signify a higher Inventive Energy. *Activity Index is analogous to*

the velocity of the particle. The PAI (Patent Activity Index) of top 10 solar energy technology IPCs for years 2014-2017 are given below.

IPC Domain	Description	BM-PAI 2014	BM-PAI 2015	BM-PAI 2016	BM-PAI 2017
H01M10/46	Accumulators structurally combined with charging apparatus with solar battery as charging system	0.27	0.27	0.29	0.31
H02J3/38	Maximum power point tracking control for photovoltaic sources	0.45	0.47	0.56	0.65
G01S3/78	Solar tracking systems	0.00	0.00	0.00	0.01
H02S20/32	Supporting structures being movable or adjustable, e.g. for angle adjustment specially adapted for solar tracking	1.00	7.13	9.38	6.81
G01S3/783	Systems for determining direction or deviation from predetermined direction using amplitude comparison of signals derived from static detectors or detector systems	0.01	0.01	0.01	0.02
H02S10/12	Hybrid wind-PV energy systems	1.00	1.00	2.31	5.16
H02S30/20	Collapsible or foldable PV modules	6.26	15.45	8.57	5.95
F24S20/20	Solar heat collectors for receiving concentrated solar energy, e.g. receivers for solar power plants	1.00	1.00	1.00	1.00
F24S40/53	Safety or protection arrangements of solar heat collectors; Preventing malfunction of solar heat collectors by venting solar heat collector enclosures	1.00	1.00	1.00	1.00
F24S40/57	Preventing overpressure in solar heat collector enclosures by venting	1.00	1.00	1.00	1.00

*BM-PAI – *Bhushan Mishra Patent Activity Index* – named after its creators

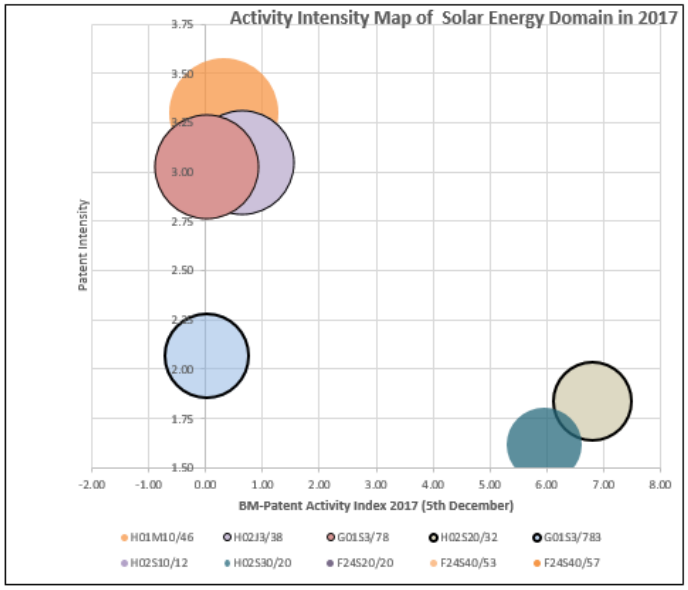
As can be seen in the above table, the PAI for IPC class H02S30/20 (Collapsible or foldable PV modules) is above 2.0 for years 2014, 2015, 2016 and 2017, indicated in green.

The PAI for H02S20/32 (Supporting structures being movable or adjustable, e.g. for angle adjustment specially adapted for solar tracking) is above 2.0 for years 2015-2017, indicated in green, and below 2.0 for the year 2014, indicated in amber. Further, the PAI for H02S10/12 (Hybrid wind-PV energy systems) is above 2.0 for years 2016-2017, indicated in green, and below 2.0 for the year 2014-2015, indicated in amber. Similarly, for the IPC classes F24S 20/20 (Solar heat collectors for receiving concentrated solar energy, e.g. receivers for solar power plants); F24S40/53 (Safety or protection arrangements of solar heat collectors; Preventing malfunction of solar heat collectors by venting solar heat collector enclosures); and F24S40/57 (Preventing overpressure in solar heat collector enclosures by venting), the PAI is below 1.0 for years 2014, 2015, 2016 and 2017, indicated by amber.

Further, the PAI for IPC classes H01M10/46 (Accumulators structurally combined with charging apparatus with solar battery as charging system); H02J3/38 (Maximum power point tracking control for photovoltaic sources); G01S3/78 (Solar tracking systems); and G01S3/783 (Systems for determining direction or deviation from predetermined direction using amplitude comparison of signals derived from static detectors or detector systems) are red (below 1.0) for the years 2014-2017. This implies that the number of Patent Applications being published in the preceding 5 years (inclusive of current year) *remains less* than the number of Patents being granted. This indicates a reducing Invention activity in the specific domain. Thus, it can be concluded that IPC domains H01M10/46; H02J3/38; G01S3/78; and G01S3/783 are seeing reducing Invention Activity and has low invention velocity from 2010 to 2017.

H02S20/32, and H02S30/20 are the prominent IPC classifications in the solar energy technology which talks about ***supporting structures being movable or adjustable, e.g. for angle adjustment specially adapted for solar tracking; and collapsible or foldable PV modules*** *respectively. The inventive activity in H02S30/20 was higher in the year 2015, since then the patent activity has been reducing as the number of Patents being granted has started increasing. Further, the inventive activity in H02S20/32 was also lower in the year 2014, since then the patent activity has been increasing. However, the inventive activity of H02S30/20 is still higher than other key IPC classes.*

Activity Intensity Maps of Top 10 Solar energy technology IPC classes in the year 2014 and 2017

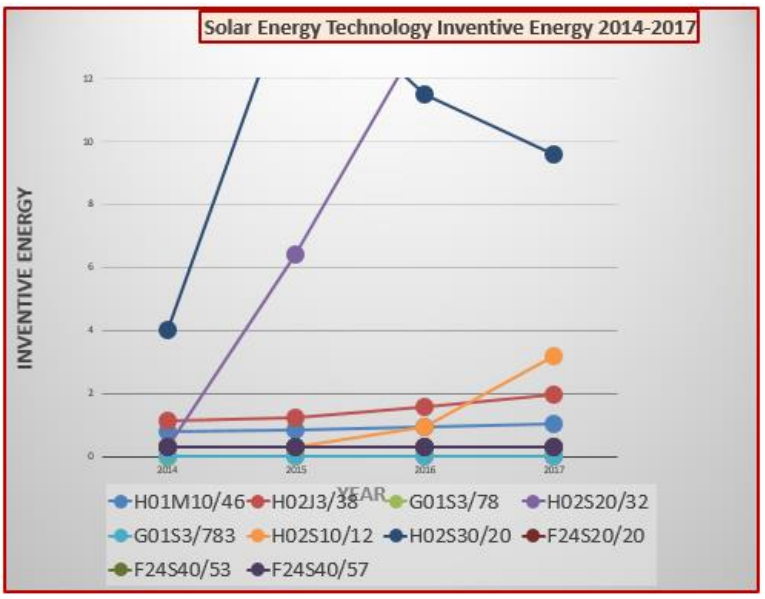


Activity Intensity Map (**AIM**) of a set of IPC classes is a Crafitti proprietary visualization of intensity in terms of a number of patents granted and patent applications published, and inventive activity in terms of relative pace of patent applications and granted patents in any IPC domain. For any year say 2014, these indices include a measure of yearly averages of last five years of a number of applications published and patents granted. For example, for 2014, these indices use data from years 2010, 2011, 2012, 2013 and 2014.

IPC Domain	Patent Activity Index				Patent Intensity				INVENTIVE ENERGY			
IPC	BM-PAI 2014	BM-PAI 2015	BM-PAI 2016	BM-PAI 2017	2014	2015	2016	2017	2014	2015	2016	2017
H01M10/46	0.27	0.27	0.29	0.31	3.15	3.20	3.25	3.30	0.84	0.88	0.96	1.03
H02J3/38	0.45	0.47	0.56	0.65	2.61	2.69	2.86	3.05	1.17	1.27	1.59	1.98
G01S3/78	0.00	0.00	0.00	0.01	3.02	3.02	3.03	3.03	0.00	0.01	0.01	0.02
H02S20/32	1.00	7.13	9.38	6.81	0.30	0.90	1.44	1.84	0.30	6.44	13.49	12.50
G01S3/783	0.01	0.01	0.01	0.02	2.03	2.03	2.05	2.07	0.02	0.02	0.03	0.04
H02S10/12	1.00	1.00	2.31	5.16	0.30	0.30	0.41	0.62	0.30	0.30	0.96	3.22
H02S30/20	6.26	15.45	8.57	5.95	0.64	0.99	1.35	1.62	4.03	15.32	11.53	9.63
F24S20/20	1.00	1.00	1.00	1.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
F24S40/53	1.00	1.00	1.00	1.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
F24S40/57	1.00	1.00	1.00	1.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Solar Energy Technology Inventive Energy of Top 10 IPC classes

Inventive Energy for the year 2014 for IPC class H01M10/46 is simply a product of Patent Activity Index for the year 2014 (in this case a value of 0.27) and Patent Intensity for the year 2014 (in this case a value of 3.15). The Inventive Energy for the year 2014 for IPC domain H01M10/46 comes out to be 0.27 x 3.15 = 0.84, as shown in the Table. In general, the Inventive Energy of IPC class H02S30/20 (Collapsible or foldable PV modules) is highest among these top 10 IPC classes.



Key Findings

Due to its inherent simplicity and utilization of substantial information on published and granted patents, the present study on the inventive energy provides a de facto standard for enterprises active in the solar energy technology to evaluate the front edge of technology in various applications of the solar energy technology.

IPC class on the Collapsible or foldable PV modules (H02S30/20) has seen the tremendous inventive energy in the 2015-2016 Index. Other two prominent IPC classes on supporting structures being movable or adjustable, e.g., for angle adjustment specially adapted for solar tracking (H02S20/32), and Hybrid wind-PV energy systems (H02S10/12) have also been quite active among the solar energy enthusiasts and R&D teams.

One of the findings from the present inventive energy study is that the patenting activity was higher in the solar energy domain in the year 2015 and 2016. Further, there is an increase in the patent activity in the maximum power point tracking control for photovoltaic sources (H02J3/38) which was lower in the year 2014-2015. Further, the filing trend in this domain is relatively better than the IPC G01S3/78 which talks about *solar tracking systems.*

Further, the reduction in Inventive Energy of H02S20/32 (supporting structures being movable or adjustable, e.g., for angle adjustment specially adapted for solar tracking) from 2016 value of nearly 9.38 to the value of 6.81 in the year 2017, *indicates the trend of Patents grants has started in the period that typically brings down the Inventive Energy as it is a function of the ratio of applications published and a patent granted for the particular year.* Furthermore, the present inventive energy study identified that inventors are active in the incremental improvements in solar panels over the last five years, but not been much innovation in the design of the actual solar panels. The photovoltaic panels are a mature technology, and most of the patents are describing the installation of the solar panels, and the management and energy distribution of the solar panels.

IPC classes with high Inventive Energy typically will have higher business potential and growth in solar energy technology. The Inventive Energy can be utilized to create the solar energy technology Inventive Strategy to find problems in high inventive energy IPC classes. This can be a leading indicator for not only any startup or disruptor but also to existing patent owners to expand and strengthen their portfolio through this guidance rather than letting serendipity and opinion about future guide their inventive effort.

As the patent examiner not only evaluate the patentability of the corresponding technology but also assess the legal aspects of the filed patent application at various levels of scrutiny before granting the patent, therefore, patent grant trends identified by the present inventive energy study in the solar energy technology will enable the decision maker with the due-diligence aspects of the solar energy technology.

Any organization willing to invest in the solar energy technology can utilize invention energy metric in general and this study in particular, as it automatically takes care of three major inputs required to understand the state of the art of solar energy technology – Patent Applications, Granted Patents and Specific IPC classes relevant to solar energy technology in a composite metric.

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