Sample Patent Landscape Study

Solar Heat Collectors

December 2020

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1. Introduction

What is a Solar Heat Collector?

A solar collector is a device that collects and/or concentrates on solar radiation from the Sun. These devices are primarily used for active solar heating and allow for the heating of water for personal use. These collectors are generally mounted on the roof and must be very sturdy as they are exposed to a variety of different weather conditions.

Image: Flat Plate Collector

The use of these solar collectors provides an alternative for traditional domestic water heating using a water heater, potentially reducing energy costs over time. As well as in domestic settings, numerous collectors can be combined in an array and used to generate electricity in solar thermal power plants.

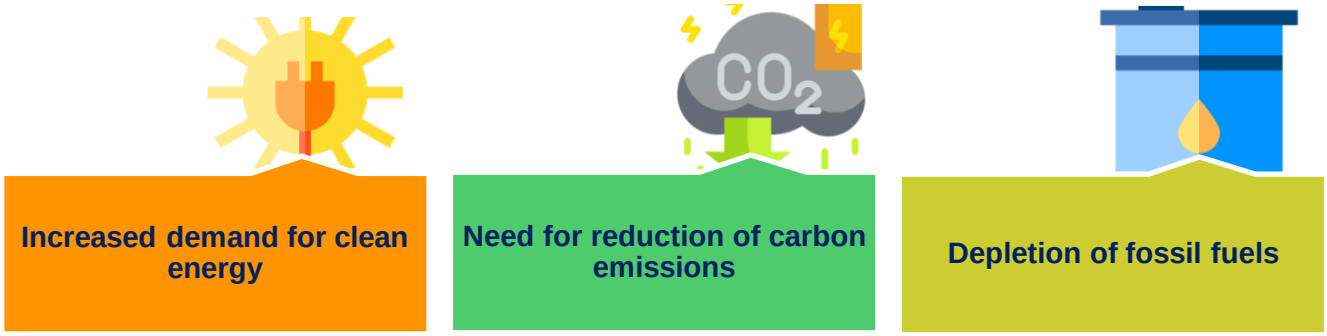
Types of Solar Collectors

There are many types of solar collectors, but all of them are constructed with the same basic premise in mind. In general, some materials are used to collect and focus energy from the Sun and use it to heat water. The simplest of these devices uses a black material surrounding pipes that water flows through. The black material absorbs the solar radiation very well, and as the material heats the water it surrounds. This is an amazingly simple design, but collectors can get very complex. Absorber plates can be used if a high-temperature increase isn't necessary, but generally, devices that use reflective materials to focus sunlight result in a greater temperature increase.

Market Growth

The global solar power market size was valued at USD 163.70 billion in 2019 and is projected to reach USD 194.75 billion by 2027, registering a CAGR of 5.9% from 2019 to 2027.

Market Drivers



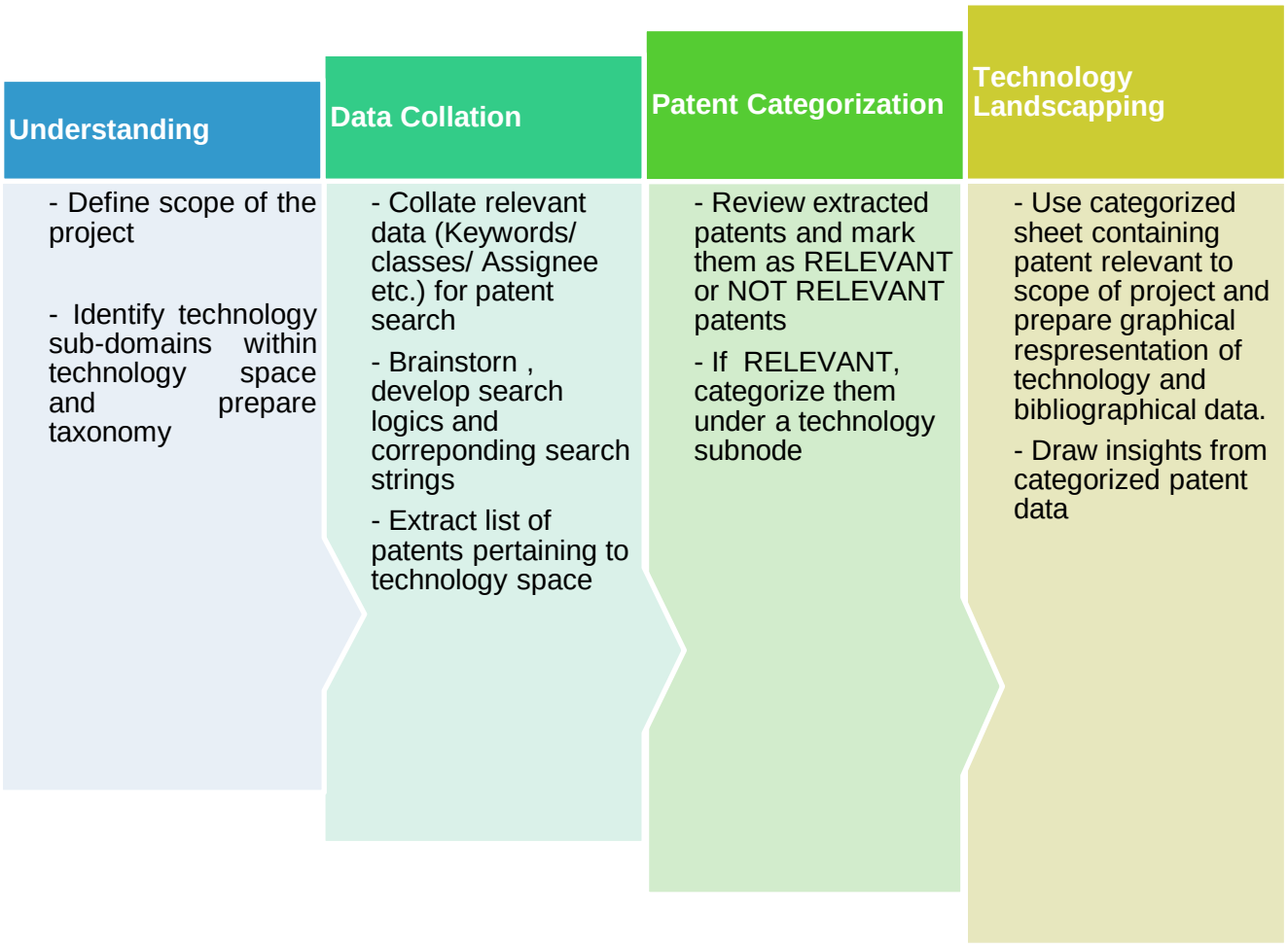
Key Players in the Solar Panel Segment

Key Players	Lointek
	Parvolen CSP Technologies
	Trivelli Energia
	SolarReserve
	Siemens
	BrightSource Energy
	SCHOTT
	Sener
	Abors green GmbH
	Torresol Energy
	Acciona
	Abengoa Solar

2. Objective of the Report

- To provide an overview of innovation trends in the Solar heat collectors domain after the Paris Agreement (2016).
- Geography-wise / technology-wise split of Patented/Patent-pending technology in the domain
- A brief study on top players and their valuable technology in the Solar Heat Collectors domain

3. Search Methodology



4. Summary

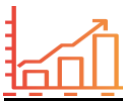
- This report explores a global landscape of patents/patent applications pertaining to Solar heat collectors Technology.

- A set of 1202 patent families filed after the Paris Agreement- 4th Nov 2016 bifurcates to a total of 1805 individual patents/applications filed in the Solar Heat Collectors domain. The same has been analyzed extensively in this report

Focus of the Claimed Inventions

Flat-Plate-Type	162
Vacuum Tube	123
Energy Storage	92
Insulation/ Thermal Insulation	53
Evacuated Tube	51
Trough-Type	38
Power Generation	38
Tracking System	37
Photo-voltaic Energy Collection	33
Hybrid Energy Collection	33
Panel Adjustment	32
Heat Pump	29
Sensor/ Temperature Sensor	28
Material	23
Industrial Processes	21
Tube/ Glass Tube	20
Construction	19
Support Structure	17
Reflector	17
Parabolic-Type	17
Over Heat Protection	16
Drying/ Agricultural Drying	13
Curved	13
Snake-Like	12
Groove-Type	11

Key Report Findings



Solar Heat Collectors Patent filings have grown each year. The year 2019-20 has witnessed a rise of 50% in patent publication.

In 2016-20, Hebei Daorong New Energy Technology emerged as the top global innovator in Solar Heat Collectors domain with 20 patent families.

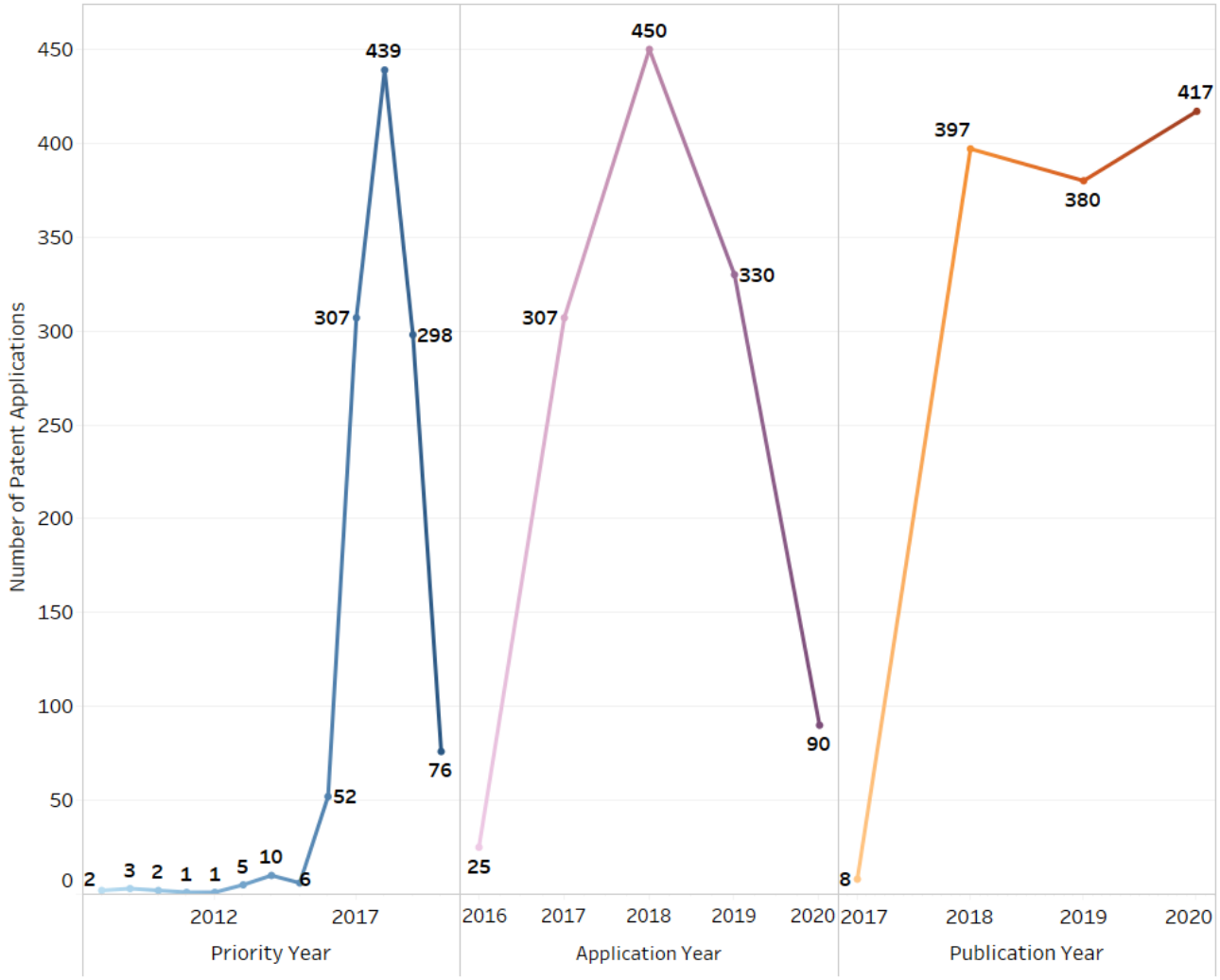
China (985 patent applications) is the biggest filing destination.

Xue Daorong (China) with 17 patent applications is the leading researcher in the Solar Heat Collectors domain.

5. Non-Technical Analysis

5.1 Priority, Filing, Publication Year Based Trend Analysis

The below graph represents priority year, application year, and publication year trends for the patent applications pertaining to Solar Heat Collectors.



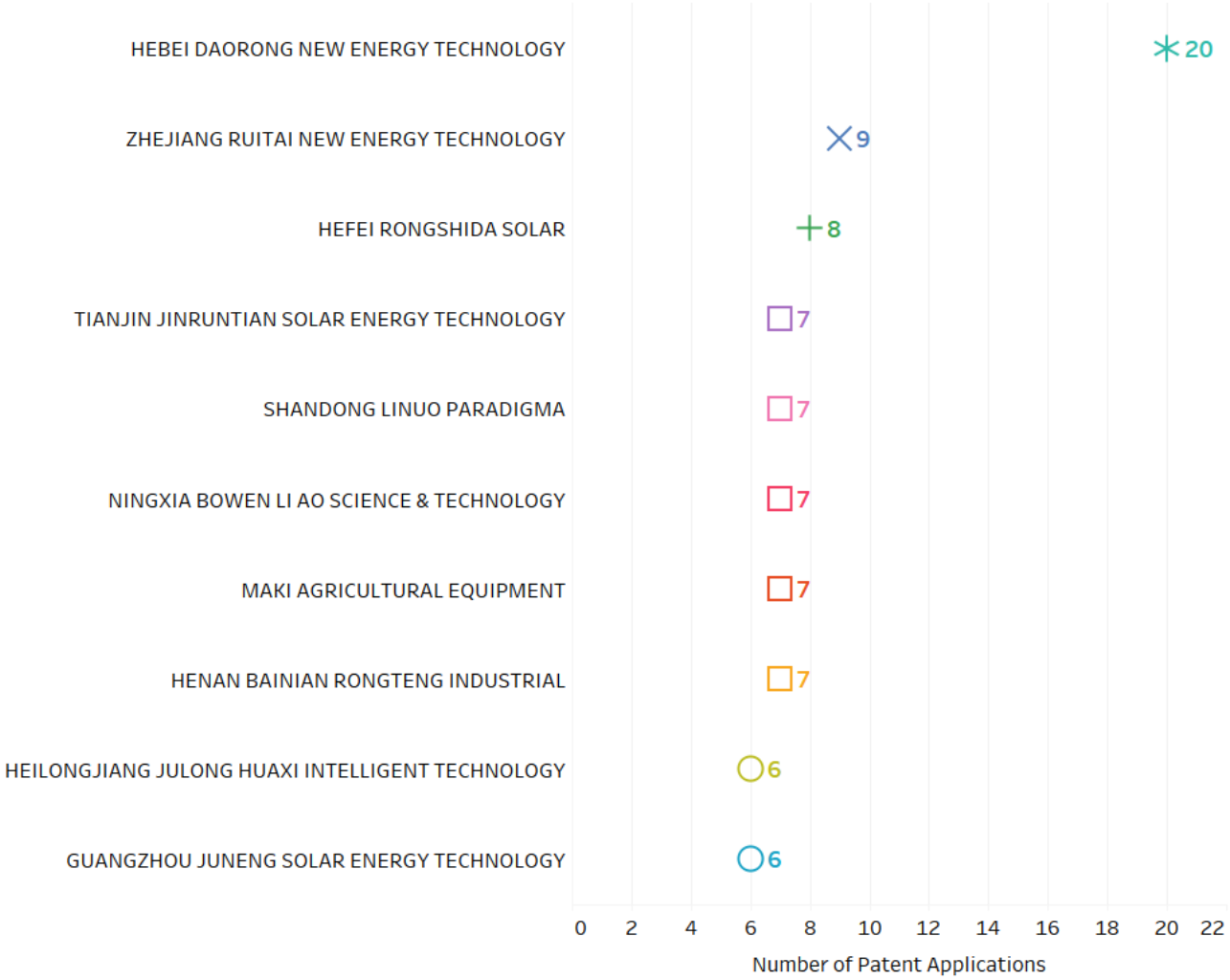
Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

Priority trend suggests that most of the patent applications that were published after the Paris Agreement claim was envisaged after the Agreement. Thus, concluding that the organizations and countries have taken the initiative very seriously and are actively innovating to come up with improved alternative technologies.

5.2 Assignee Based Trend Analysis

5.2.1 Major Assignees – Companies

The below graph represents some major companies in the technology domain.

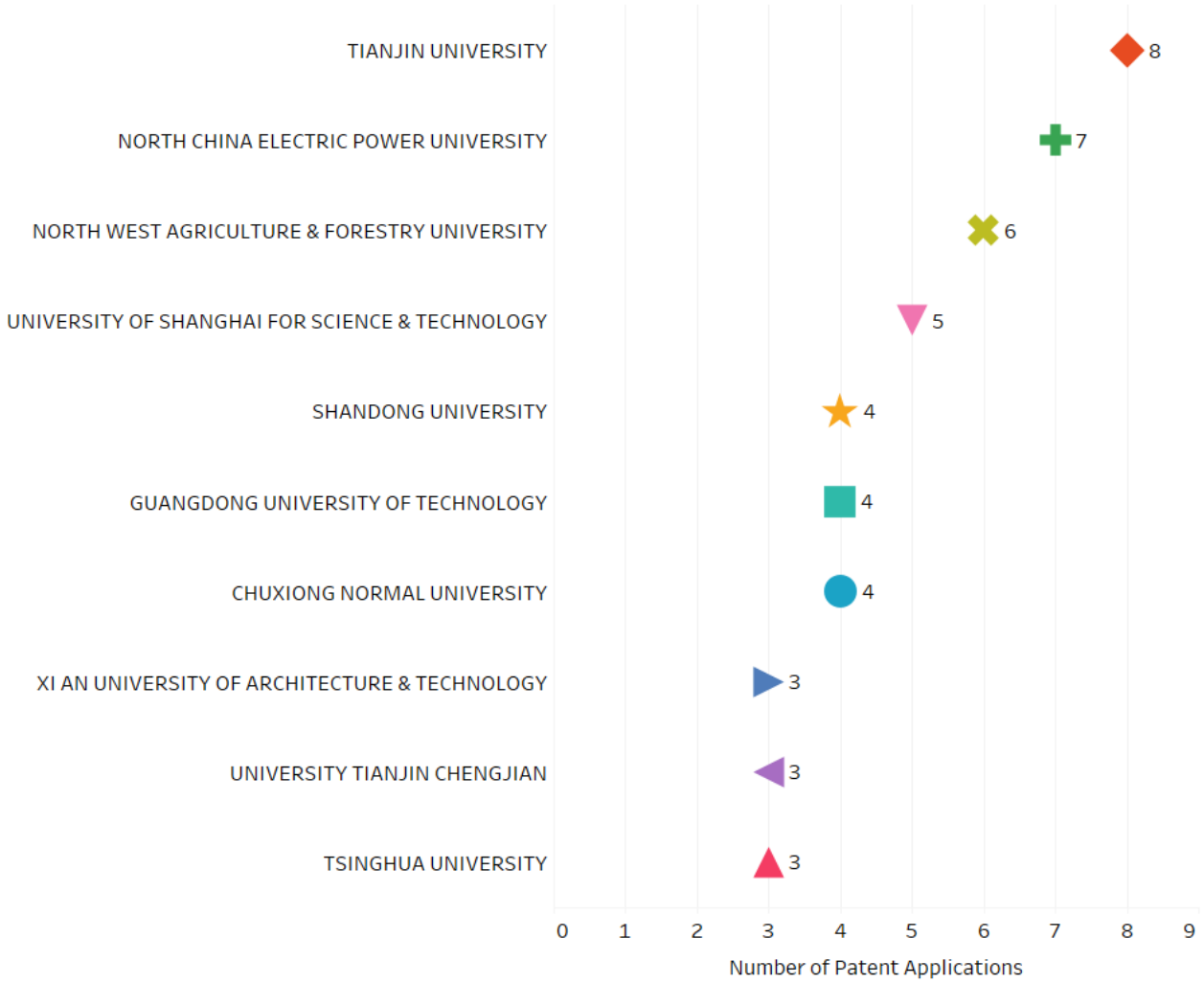


Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

China's Hebei Daorong New Energy Technology (20 patent families) and Zhejiang Ruitai New Energy Technology (9 patent families) are the leading players in the domain followed by Hefei Rongshida Solar (8 patent families).

The Chinese government places a priority on investing in renewable energy primarily because it enables the country to tackle problems of air and water pollution and mitigate risks of socio-economic instability. Expanding renewable energy became one of seven categories of business that receive special attention including loans and tax incentives under China's five-year plans. This has resulted in rise in the development of Solar Heat Collectors Technology in China.

5.2.2 Major Assignees – Universities & Research Institutes

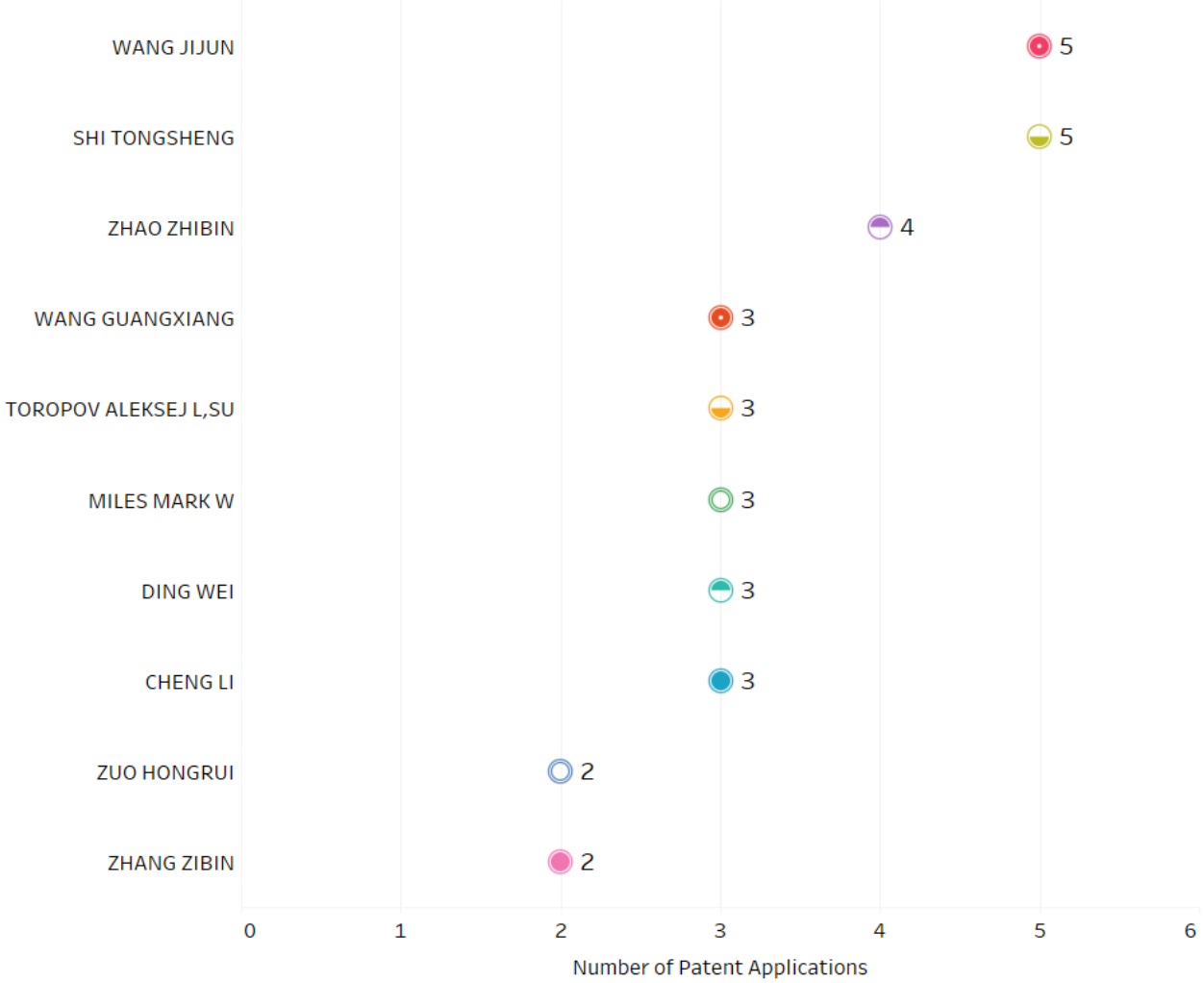


Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

Chinese Institutions are actively supporting the Government's ideology of promoting green energy sources. Interestingly, in the last couple of years, Chinese Universities have predominantly shown interest in acquiring patent rights in Solar Heat Collectors domain among other alternative energy sources.

Tianjin University, North West Agriculture & Forestry University, the University of Shanghai for Science & Technology, and Shandong University are key and prominent university/ research institutes that have filed patents on Solar Heat Collectors domain.

5.2.3 Major Assignees – Individual Inventors

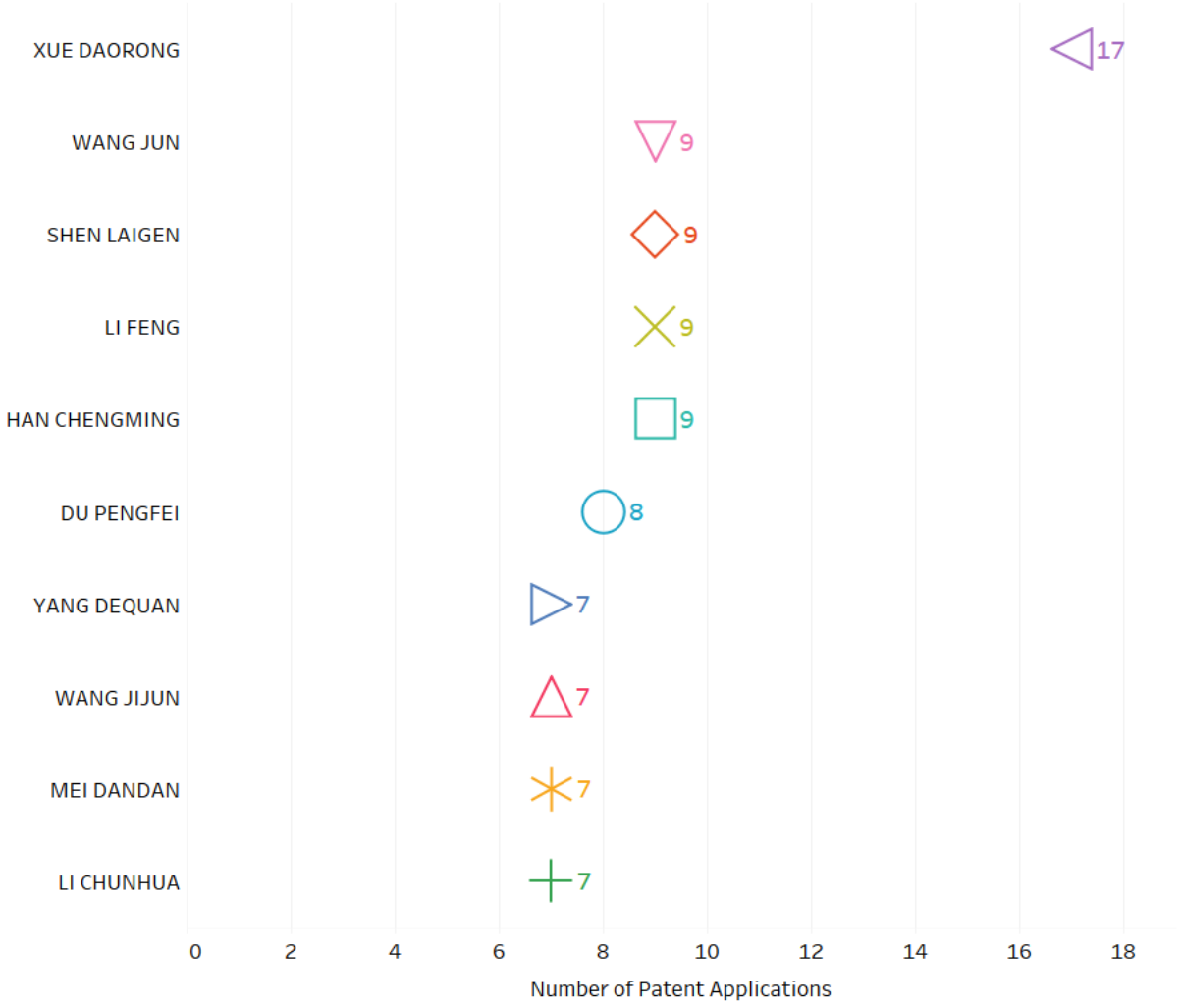


Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

Wang Jijun and Shi Tongsheng with 5 patent families are the major individual inventors in the domain followed by Zhao Zhibin with 4 patent families.

5.3 Key Inventors

The below graph names inventors, with the greatest number of innovations on their name.

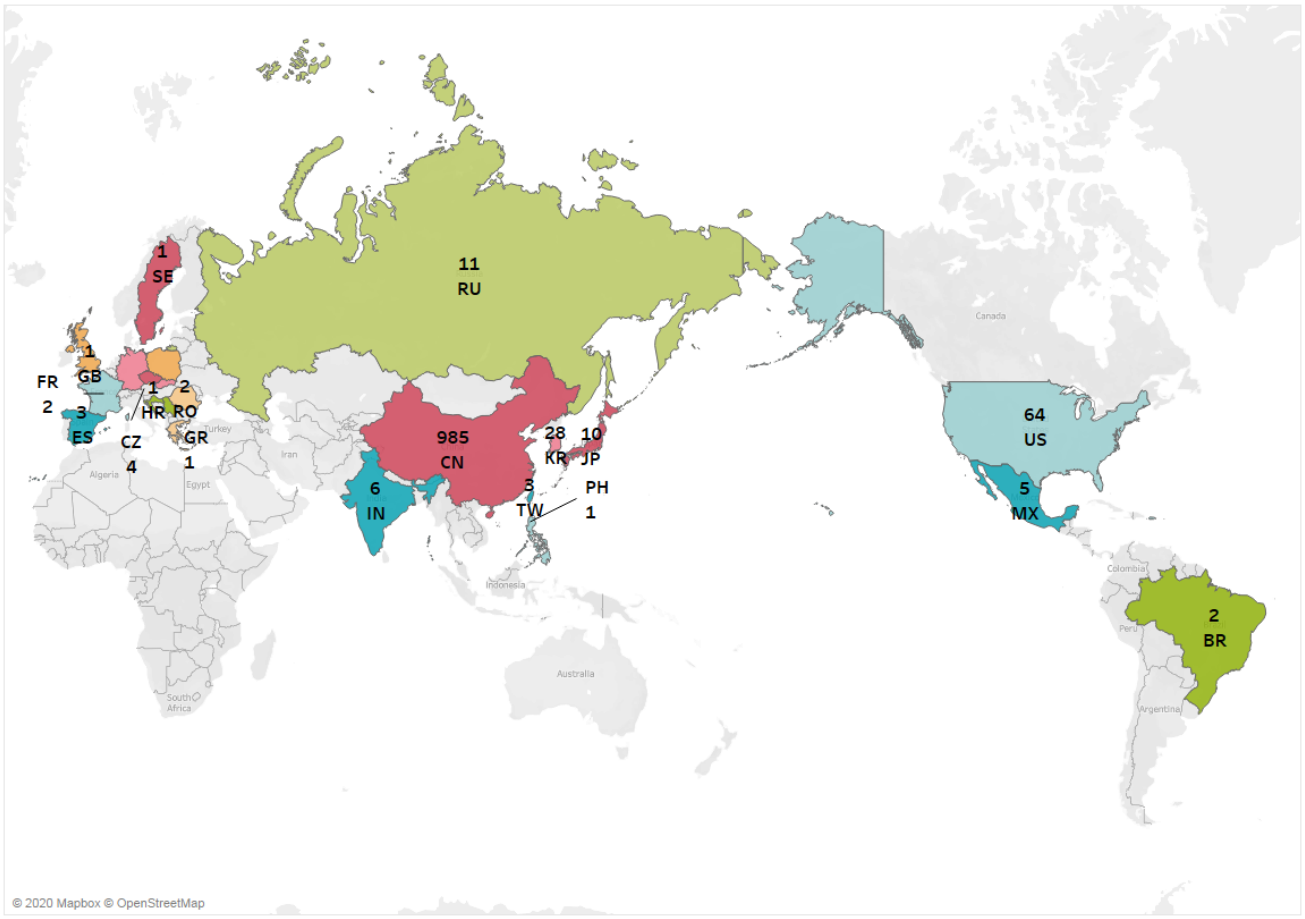


Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

China's Xue Daorong, CEO of Hebei Daorong New Energy Technology Co., Ltd is key inventor in the domain with 17 patent families. Daorong New Energy closely follows national policies, guidelines, and strategic development plans, focuses on the development of clean energy.

5.4 Geography Based Trend Analysis

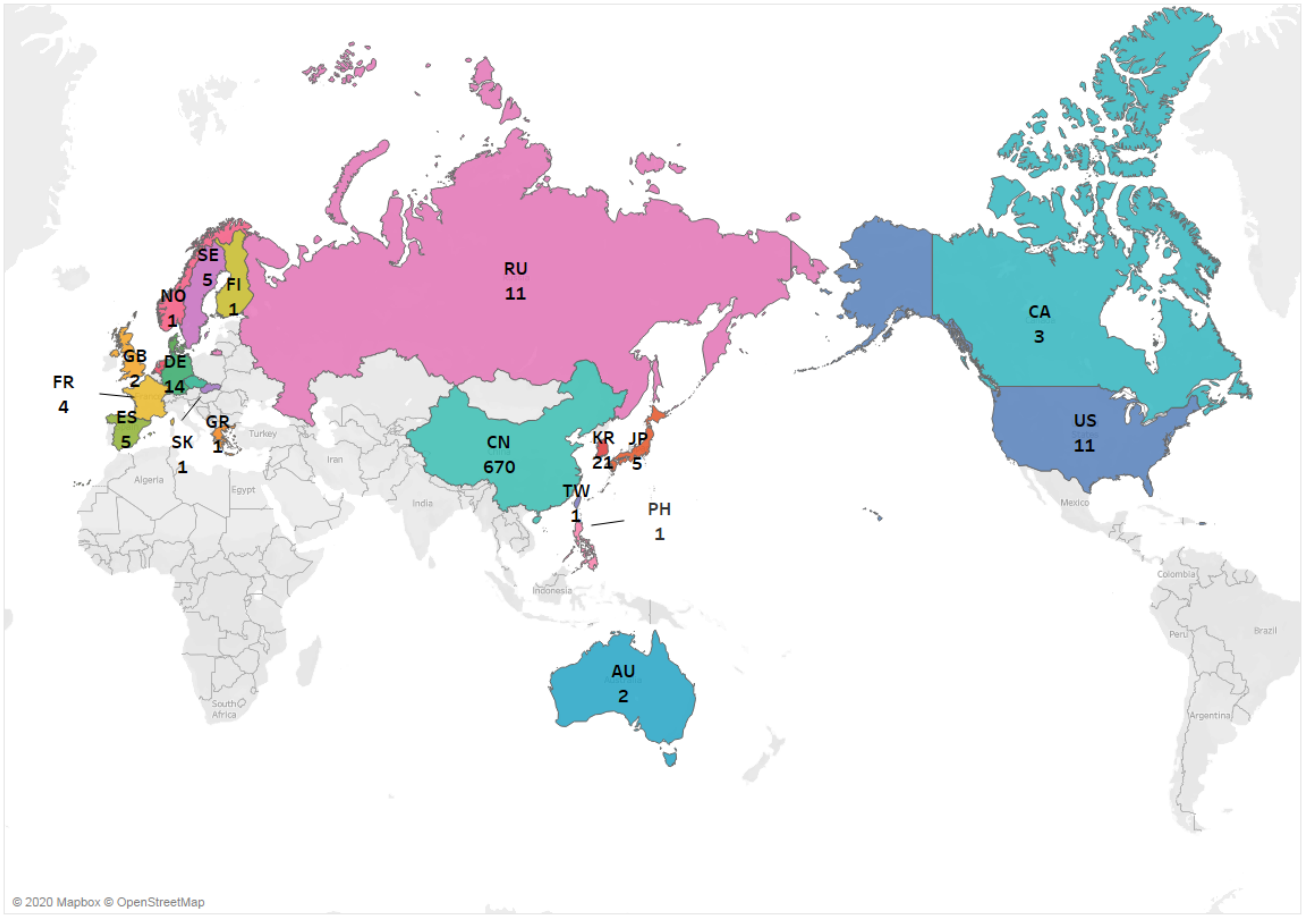
5.4.1 Geographical Distribution of Patent Application Filings



Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

It is interesting to note that out of 1202 patent applications filed after the Paris Agreement (04-11-2016), almost 983 applications were from China, amounting to 82% (approximately) of total patent applications, followed by the US and Korea. It is primarily due to the Government's role and interest in promoting start-ups and universities to explore green energy technologies.

5.4.2 Geographical Distribution of Granted Patent

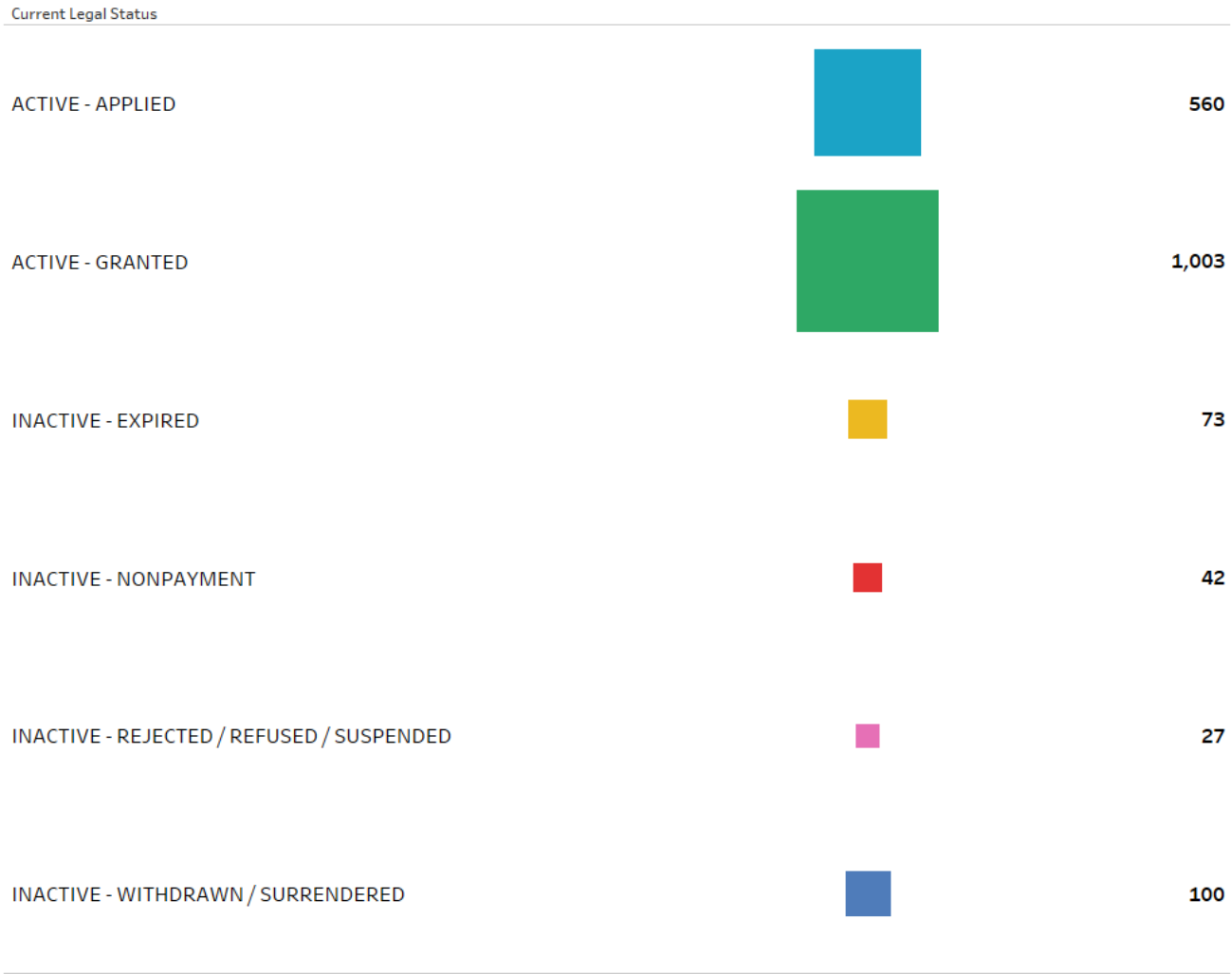


Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

Trend related to the geographical distribution of patent grants demonstrate that Chinese organizations are not only filing applications for patent but are also acquiring patent rights on their claimed inventions. Around 70% of the total documents published by the Chinese Patent and Trademark office since Paris Agreement (2016) have already been converted into patents rights

5.5 Current Legal Status (Based on Expanded Family Members)

The below graph shows the results plotted by their latest calculated legal status



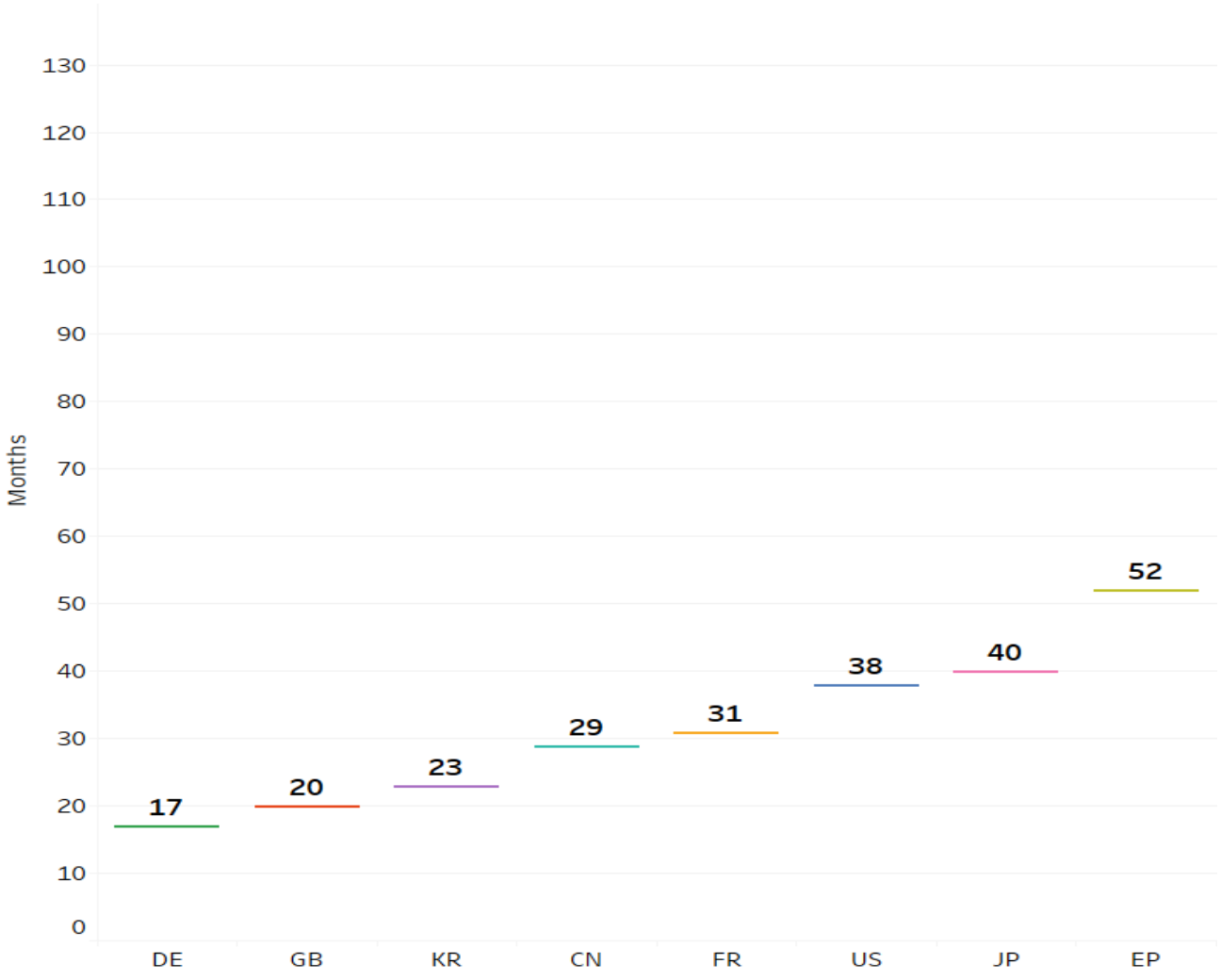
Note 1: The analysis is based on the patent applications filed after the Paris Agreement i.e. 2016-11-04.
Note 2: Attributed to non-published patent applications, there may be a higher count in the years 2017-2020.

Trend related to Legal Status of Patent Applications demonstrate that 85% of active applications indicate the advancement in the Solar Heat Collectors technology and the possibilities of path-breaking inventions to come in coming future.

It is also to be noted that the inactive patents 7%, that includes rejected/refused/suspended and withdrawn/surrendered patents are way less than that of the active patents/ applications (80%), signifying the major research are under-way in the Solar Heat Collectors technology.

5.6 Average Time to Grant

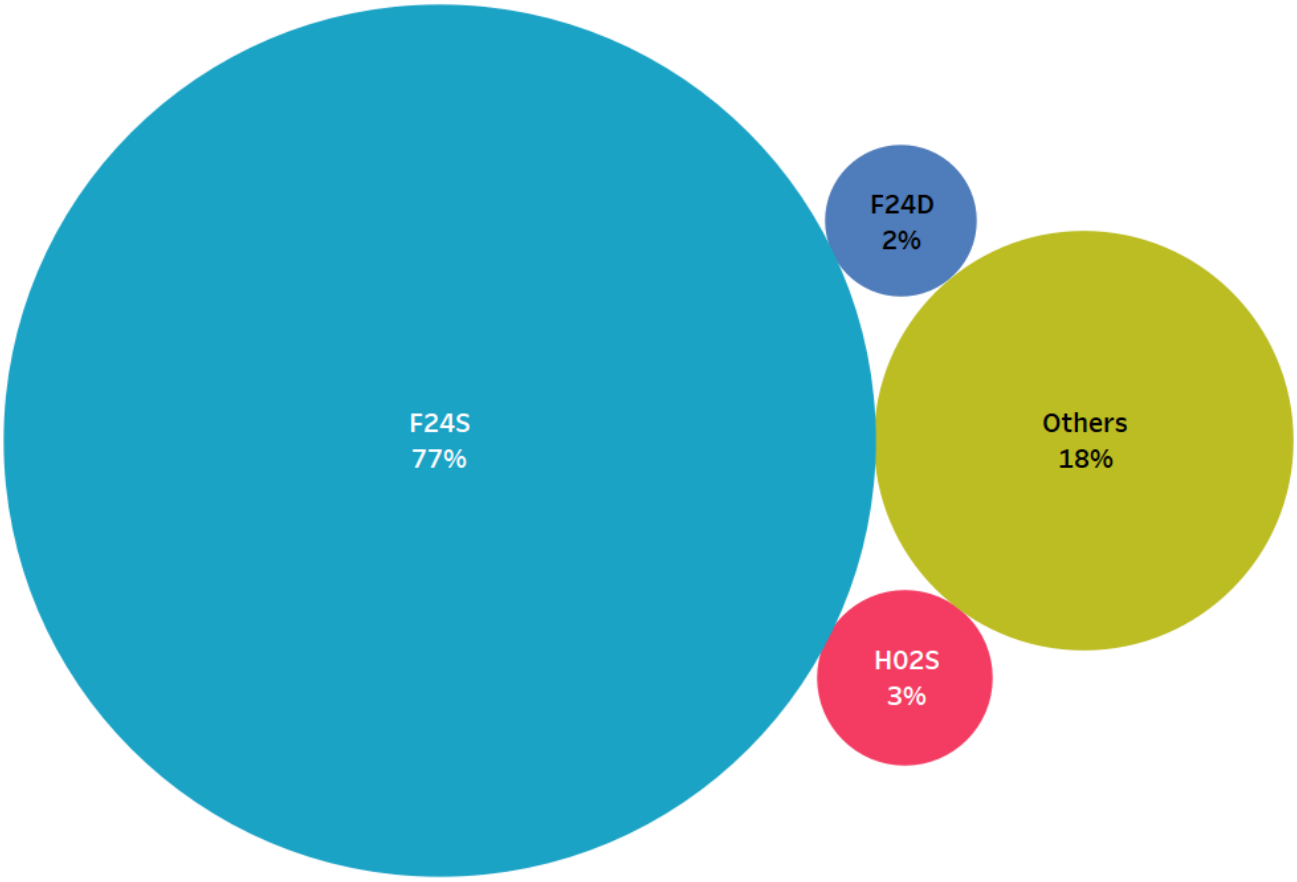
The below graph shows the average prosecution time by a country for filing in the current technology area. The count also represents an average number of months taken for an application to get granted in that jurisdiction.



It is interesting to note that Patent offices across the globe are also appreciating the innovations and efforts in achieving a clean environment and are expediting the patent procurement process.

5.8 International Patent Classification

The below-packed bubbles represent frequently assigned, international patent classes.

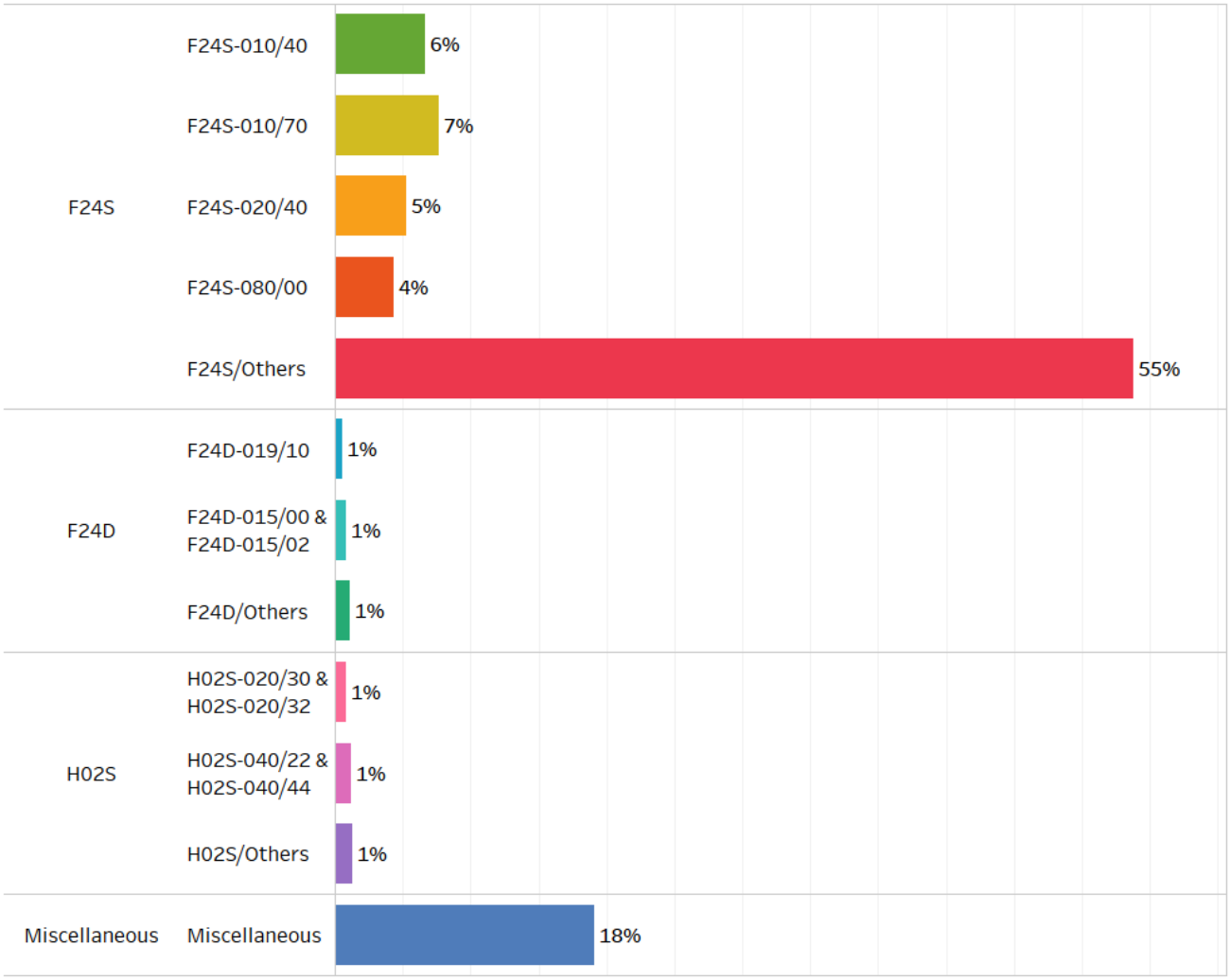


IPC Definitions

IPC	Definition
F24S	Solar heat collectors; solar heat systems
H02S	Generation of electric power by conversion of infra-red radiation, visible light or ultraviolet light, e.g. using Photovoltaic [PV] modules
F24D	Domestic- or space-heating systems, e.g. central heating systems; Domestic hot-water supply systems;

5.8.1 International Patent Sub-Classification Based Trend

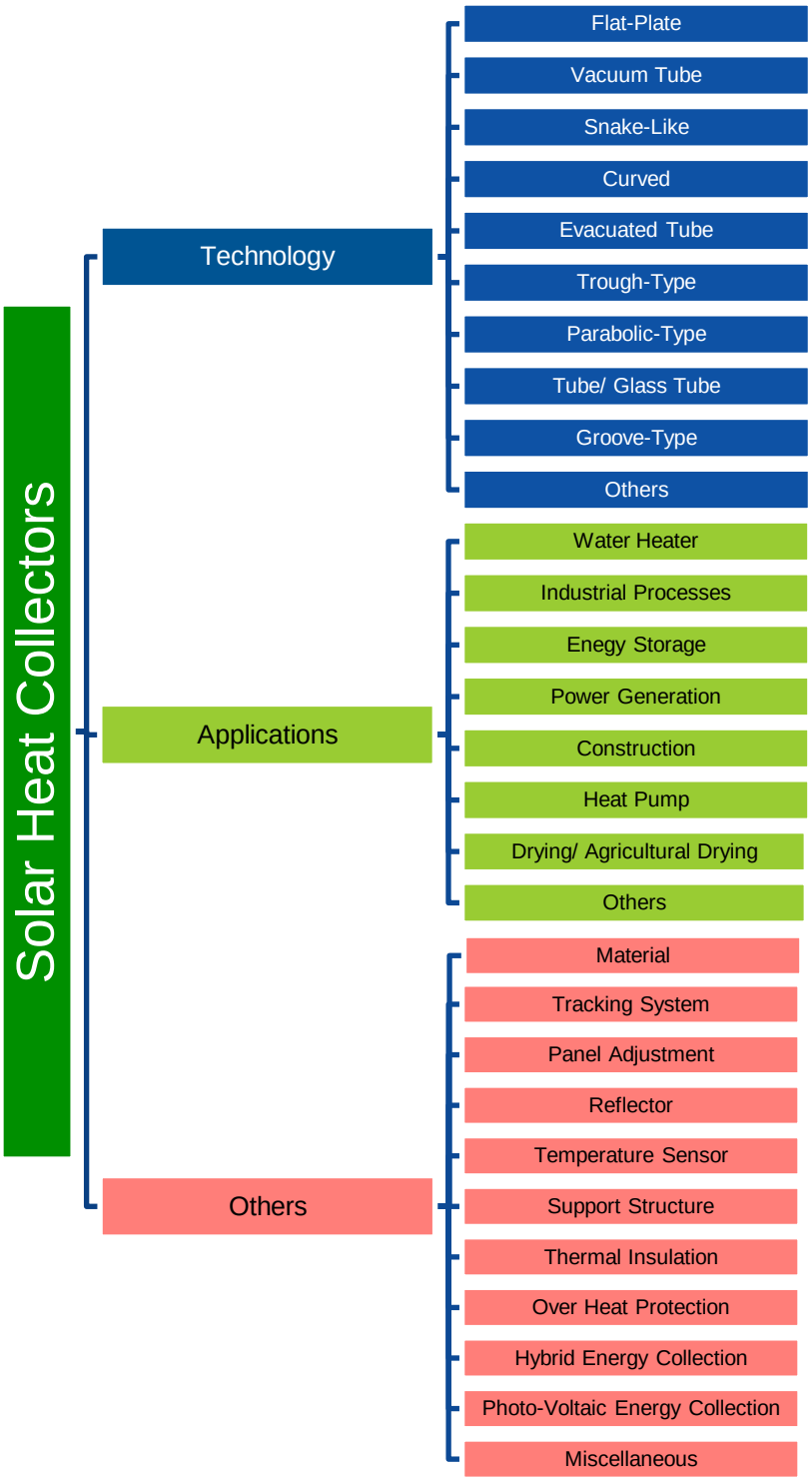
The below graph represents sub-classes pertaining to one of the main patent classes.



6. Technical Analysis

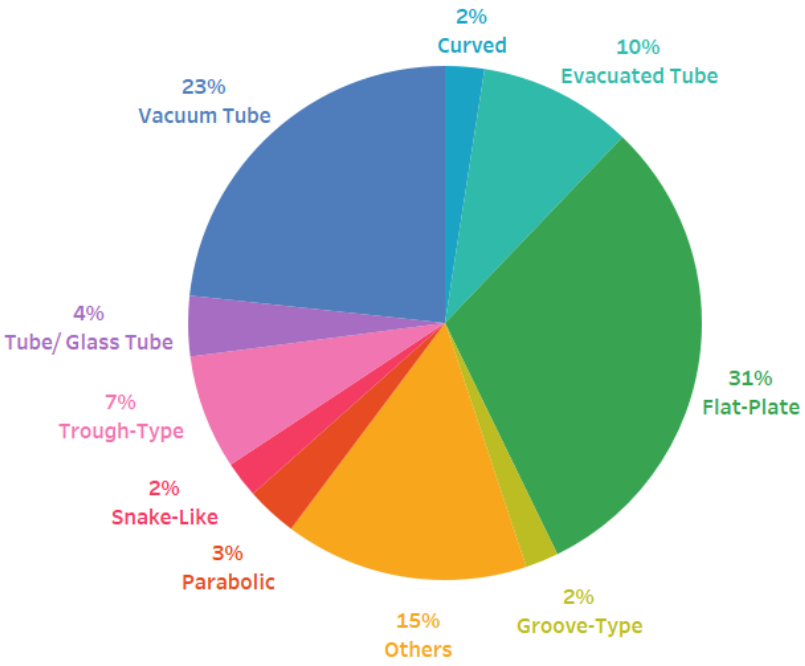
6.1 Taxonomy Developed for Bucketing of Relevant Patent Documents

A set of 1202 patent families were analyzed in-depth to identify the focus areas of the Patents related to Solar Heat Collectors.



6.2.1 Distribution of Patents/Applications Pertaining to 'Design'

This category deals with patents/applications pertaining to 'Design' being incorporated in the Solar Heat Collectors. The Below representation shows sub-categories, such as Flat-Plate, Vacuum Tube, Evacuated Tube, Groove-Type, Parabolic, Trough-Type, Tube/ Glass Tube, Snake-Like-Type, Curved, and others.

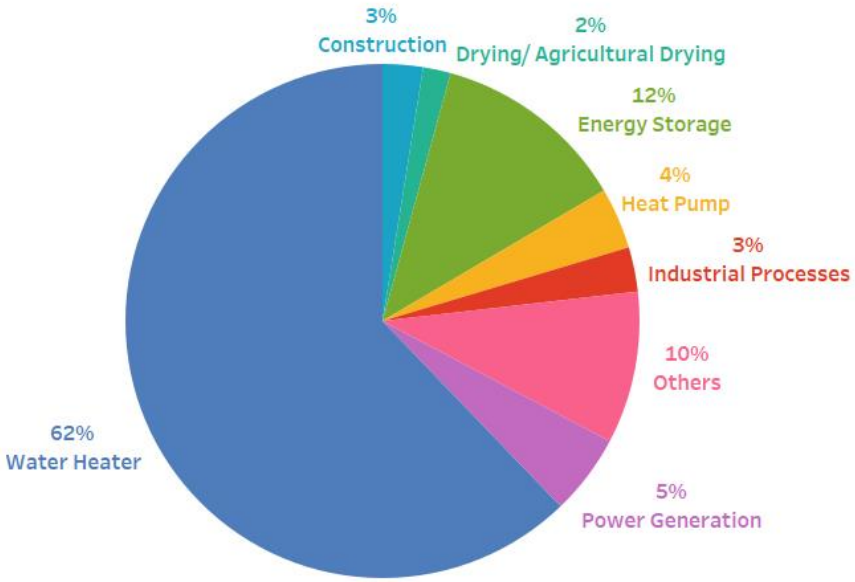


Most patents published during 2016-20 relate to Flat-Plate Type solar collectors (31%) followed by Vacuum Tube (23%) and Evacuated Tube (10%) type collector.

Since flat-plate collectors are Easy to manufacture, cost-effective, collect both beam and diffused radiations, permanently fixed (no sophisticated positioning or tracking equipment is required), and have a low maintenance cost, they are heavily preferred by researchers and companies over other designs.

6.2.2 Applications area of Solar Heat Collectors

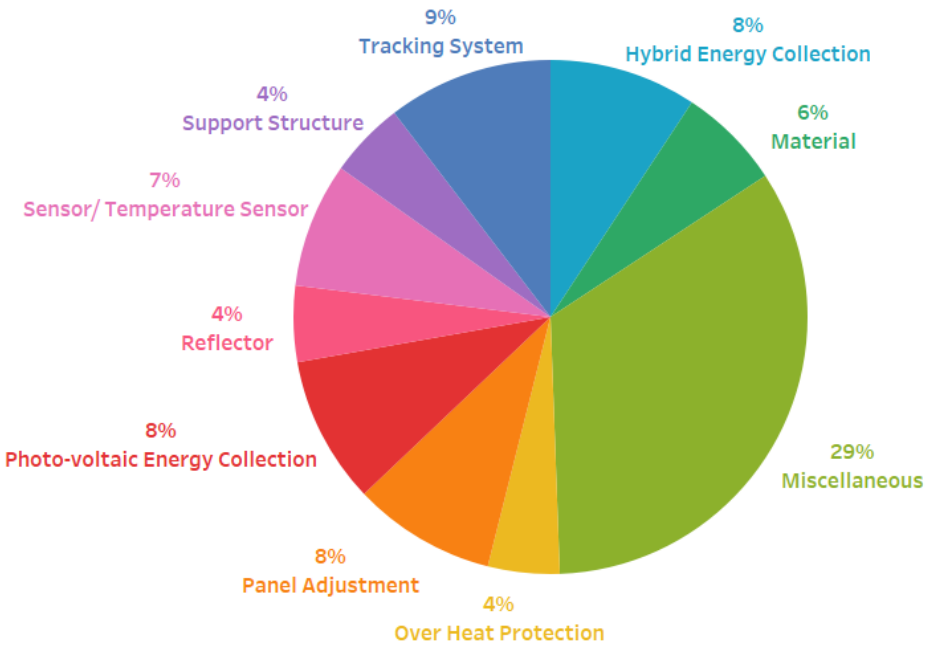
Though most patent applications published during these years have related to heating water and energy generations, a few companies have found new avenues for solar panels and are now inducting them in other sectors like agriculture, construction, industrial processes, etc.



Solar collectors have been used in a variety of applications and it has been observed from the above graph that the Maximum number of patents/applications filed during 2016-20 used in Water Heater (62%), followed by Energy Storage (12%) and Power Generation (5%). As can be seen, solar energy systems can be used for a wide range of applications and provide significant benefits, therefore, they should be used whenever possible.

6.2.3 Technologies used in Solar Panels

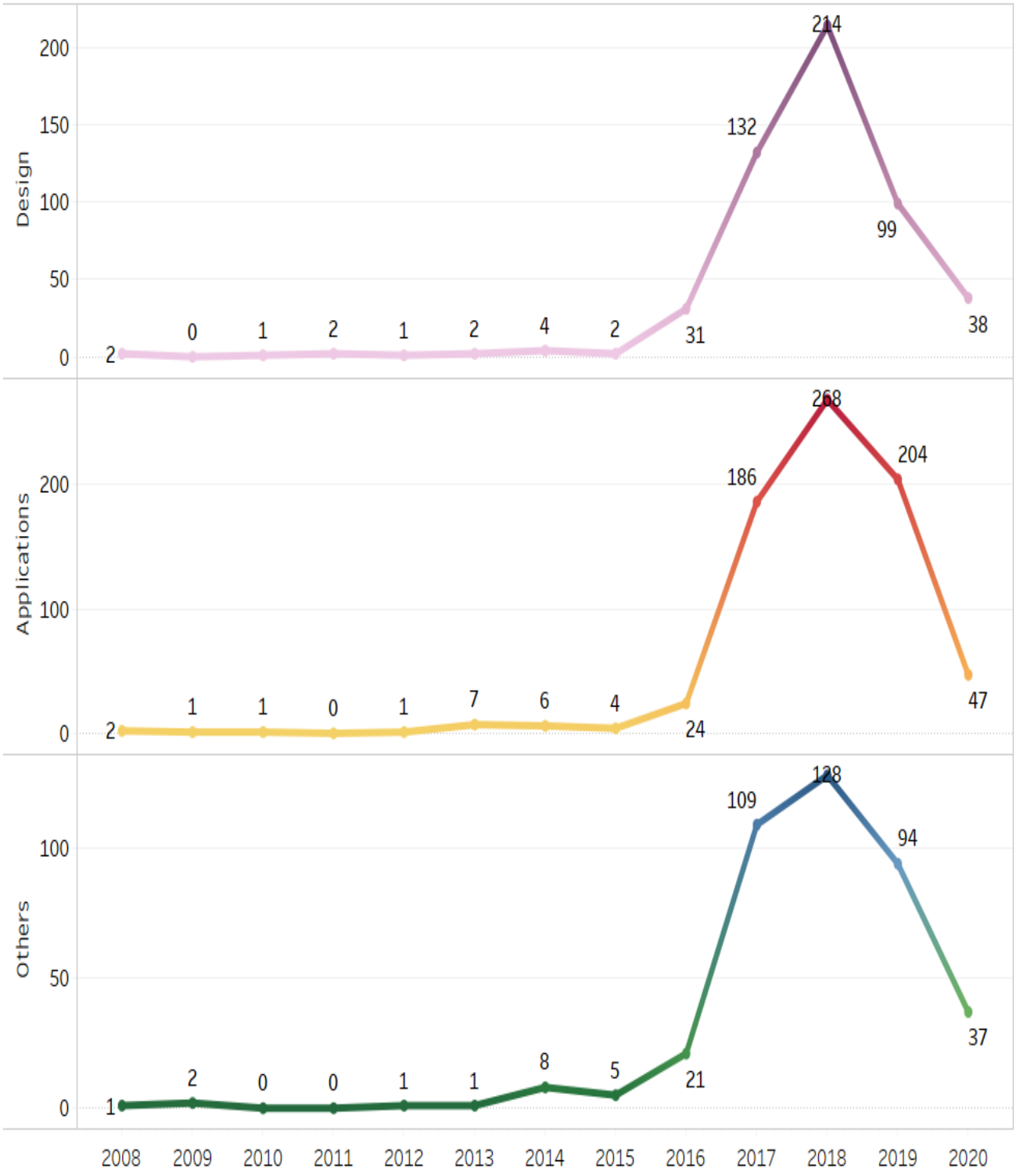
Below representation shows sub-categories of Panel Adjustment, Overheat Protection, Photo-Voltaic Energy Collection, Reflector, Sensor/ Temperature Sensor, Support Structure, Tracking System, Hybrid Energy Collection, Material, and Miscellaneous.



Since Solar Heat Collectors technology is growing at a fast pace, researchers have filed patents related to each aspect of the technology.

6.3 Technology Distribution V Filing Date

The below graph demonstrates the technology distribution of patent applications across the years.



6.4 Technology Distribution V Major Assignee (Companies)

The below highlighted tabular chart demonstrates the technology distribution of patent applications against major assignee companies in the technology domain.

		HEBEI DAORONG NEW ENERGY TECHNOLOGY	HEFEI RONGSHIDA SOLAR	SHANDONG LINUO PARADIGMA	TIANJIN JINRUNTIAN SOLAR ENERGY TECHNOLOGY	ZHEJIANG RUITAI NEW ENERGY TECHNOLOGY
Applications	Drying/ Agricultural Drying	2				
	Energy Storage	5		1	1	1
	Heat Pump	1				
	Industrial Processes	1				
	Others	1				1
	Water Heater	5	6	1	2	4
Design	Curve					
	Evacuated Tube			4		1
	Flat-Plate-Type	1	5	1	7	2
	Groove-Type	2				
	Others	1		1		1
	Trough-Type	4		1		
	Tube/ Glass Tube- Type	1				
	Vacuum Tube	2		1		1
Others	Hybrid Energy Collection	6				
	Insulation/ Thermal Insulation	4		1		1
	Material			3		
	Miscellaneous			1	1	1
	Over Heat Protection	5				
	Panel Adjustment	1				
	Photo-voltaic Energy Collection	1				
	Sensor/ Temperature Sensor	2				2
	Support Structure	3				
	Tracking System	1				

The Major assignee in the Solar Heat Collector are “Hebei Daorong New Energy Technology” (20 patent families), “Zhejiang Ruitai New Energy Technology” (9 patent families), “Hefei Rongshida Solar” (8 patent families), “Tianjin Jinruntian Solar Energy Technology” (7 patent families), and “Shandong Linuo Paradigma” (7 patent families).

6.5 Technology Distribution V Major Assignee (Universities & Research Institutes)

The below highlight tables demonstrate the technology distribution of patent applications against major assignee (universities & research institutes) in the technology domain.

		NORTH CHINA ELECTRIC POWER UNIVERSITY	NORTH WEST AGRICULTURE & FORESTRY UNIVERSITY	SHANDONG UNIVERSITY	TIANJIN UNIVERSITY	UNIVERSITY OF SHANGHAI FOR SCIENCE & TECHNOLOGY
Applications	Energy Storage				1	1
	Heat Pump	2		2		
	Power Generation			1		
	Water Heater	2	2	2	2	2
Design	Curve	1	1	1		
	Flat-Plate-Type		3		1	2
	Others	1	1	1	1	
	Parabolic-Type	1		1		
	Snake like/Zigzag					1
	Trough-Type	2		2		
	Vacuum Tube		1		2	
Others	Monitoring	1		1		
	Panel Adjustment	2	2	2		
	Photo-voltaic Energy Collection	1	1	1		1
	Reflector	1	1	1		
	Tracking System	1	5	1	1	
	Miscellaneous		1		1	

"Tianjin University" (8 Patent Families), "North China Electric Power University" (7 patent families), "North West Agriculture & Forestry University" (6 patent families), "The University of Shanghai for Science & Technology" (5 patent families) and "Shandong University" (6 patent families) are the major university/ research institute applicants.

6.6 Key Patents

Publication Number	Brief Summary
WO2012121712A1 Trough solar collector module [Abengoa Solar Inc.]	A concentrating solar collector module comprises a reflector having a reflective front surface shaped to concentrate incoming solar radiation onto a focal line, the reflector having two lengthwise edges parallel to the focal line and two ends defining the length of the reflector. The module further comprises first and second rails, one rail attached to the reflector at each of the lengthwise edges and extending substantially the length of the reflector, and a set of truss connectors attached to the rails. The truss connectors and rails comprise ways that enable constrained sliding engagement of the truss connectors along the rails before attachment of the truss connectors to the rails. The module further includes a plurality of framing members connected to the truss connectors.
DE102016201652B3 Method for discharging a hydrogen storage system in parabolic trough receivers [Schott AG]	A method for discharging hydrogen storage, which is located in the annular space of a receiver tube, wherein the annular space between an outer cladding tube and an inner absorber tube of the receiver tube is formed and the outer cladding tube is connected via a wall gas-tight with the absorber tube. The wall is usually made of metal and contains a glass-metal transition element, a strain compensation element, and other fasteners.
WO2016181709A1 Solar heat collector [Toyo Engineering]	A solar heat collector with high heat collection effect is provided. The solar heat collector includes a first heat collection pipe and a second heat collection pipe. The first heat collection pipe receives reflected light from a single-axial tracking solar-type reflective mirror group to collect heat. The second heat collection pipe receives reflected light from the single-axial tracking solar-type reflective mirror group and dual-axial tracking solar-type reflective mirror groups to collect heat. The second heat collection pipe has an amount of heat collection per unit area larger than the first heat collection pipe. Therefore, compared with the use of only the first heat collection pipe, this ensures obtaining larger energy.

US20160154082A1 Dual axis tracking device [WTS]	Systems and methods for continuously or intermittently determining the location of an object as it moves across the sky, and re-positioning the payload to direct it toward the moving object.
US20160146507A1 Solid-state solar thermal energy collector [Planet A Energy]	Apparatus and methods to provide a concentrating solar energy collection system that stores its energy in a proximal bed of solid-state material. Whereas the application of the invention disclosed herein is presented in the contexts of home solar thermal systems and of concentrating solar power, the apparatus and methods are generally applicable to any system in which it is desirable to store large amounts of heat in a small volume, for later use.
CN104154666A Solar composite tube, solar composite bed comprising the same, and solar cold and heat supply system comprising a solar composite bed [Zhongying Changjiang Internat Invest Guarantee Co Ltd.]	A solar heat collecting and adsorbing composite pipe and a solar heat collecting and adsorbing composite bed thereof and a cooling and heating system thereof.
WO2014107688A1 Systems and methods for selectively producing steam from solar collectors and heaters for processes including enhanced oil recovery [Glasspoint Solar, Inc.]	Systems and methods for selectively producing steam from solar collectors and heaters, including techniques for increasing the steam production efficiency for enhanced oil recovery processes by varying the energy contributions from each of the foregoing components.
US8707947B2 Solar collector [Solfast Pty Ltd]	A heat-regulating medium defining a cavity therein and having an aperture communicating with the cavity for allowing solar energy incident on the aperture to enter the cavity through the aperture, and an energy collection device disposed of in the cavity and in thermal contact with the heat-regulating medium to collect solar energy entering the cavity.
US20100217724A1 Automated solar collector installation design including version management [Sun Power Corp]	A computer-based user interface for designing a solar collector installation.
US9816728B2 Solar thermal collector and building accessory structure [Hsiu-Lin Peng]	A building-integrated solar thermal collector and a building accessory structure using the solar thermal collector.

7. Take Away's

Scope of Landscape study	Report explores patent landscape of innovations relating to Solar Heat Collectors technology filed after Paris Agreement, 2016-11-04
Extracted Patents	A set of 1202 patent families (filed in the years 2016-20) that bifurcates to a total of 1805 individual patents/applications filed in Solar Heat Collectors domain were analyzed.
Patenting Trend	As inferred from the analyzed dataset, there is a rise in patent filing activities in Solar Heat Collectors after Paris Agreement, and 2018 has witnessed maximum number of patent application filings.
Birthplace of technologies	Solar Heat Collectors technology is dominated by Chinese Groups, making up more than 82% of the total families filed during the years 2016-20.
Key Players	Globally, top players within this technology are China's Hebei Daorong New Energy Technology (20 patent families) and Zhejiang Ruitai New Energy Technology (9 patent families) are the leading players in the domain followed by Hefei Rongshida Solar (8 patent families).
Top Innovators	During 2016-20, Xue Daorong, Wang Jun, Shen Laigen, Li Feng, Han Chengming, Du Pengfei are leading innovators in Solar Heat Collectors domain, and Yang Dequan, Wang jijun, Mei Dandan, and Li Chunhua also have significant contributions.
Highlighted Technologies	Patent publications particularly focus on Flat-Plate-Type (162), Vacuum Tube (123), Snake-Like (12), Curved (13), Evacuated Tube (51), Trough-Type (38), Parabolic-Type (17), Tube/ Glass Tube (20), Groove-Type (11), Water Heater (467), Industrial Processes (21), Energy Storage (92), Power Generation (38), Construction (19), Heat Pump (29), Drying/ Agricultural Drying(13), Material (23), Tracking System (37), Reflector (17), Panel Adjustment (32), Sensor/ Temperature Sensor (28), Support Structure (17), Insulation/ Thermal Insulation (53), Over Heat Protection (16), Hybrid Energy Collection (33), Photo-voltaic Energy Collection (33), Miscellaneous (273).
Future of the technology	Based on available patent data, significant growth, and further IP certainty in Solar Heat Collectors technology is expected in the coming years. Further, monitoring of the patent landscape will allow the field to be fully appreciated.

Appendix- A

IPC- Subclass Definitions:

IPC-Subclass	Definition
F24S	Solar heat collectors; solar heat systems
F24S10/00	Solar heat collectors using working fluids
F24S10/40	In absorbing elements surrounded by transparent enclosures, e.g. evacuated solar heat collectors
F24S10/70	With enlarged surfaces, e.g. with protrusions or corrugations (collectors comprising porous material or permeable masses directly contacting the working fluids)
F24S20/00	Solar heat collectors specially adapted for particular uses or environments
F24S20/40	Solar heat collectors combined with other heat sources, e.g. using electrical heating or heat from ambient air
F24S80/00	Details, accessories or component parts of solar heat collectors not provided for in groups
H02S	Generation of electric power by conversion of infra-red radiation, visible light or ultraviolet light, e.g. using Photovoltaic [PV] modules
H02S20/00	Supporting structures for PV modules
H02S20/30	Supporting structures being movable or adjustable, e.g. for angle adjustment
H02S20/32	Specially adapted for solar tracking
H02S40/22	Light-reflecting or light-concentrating means (directly associated with the PV cell or integrated with the PV cell)
H02S40/44	Means to utilise heat energy, e.g. hybrid systems producing warm water and electricity at the same time (directly associated with the PV cell or integrated with the PV cell)
F24D	Domestic- or space-heating systems, e.g. central heating systems; Domestic hot-water supply systems;
F24D15/00	Other domestic- or space-heating systems
F24D15/02	Consisting of self-contained heating units, e.g. storage heaters
F24D19/00	Details (of water or air heaters F24H 9/00; of heat-exchange or heat-transfer apparatus, of general application F28F)
F24D19/10	Arrangement or mounting of control or safety devices (control valves F16K; only the heater being controlled F24H 9/20)

Appendix- B

References & Credits:

[1] Solar collector
[2] Solar Thermal Collectors Market
[3] Information on solar thermal systems
[4] Solar thermal collector
[5] Icons Courtesy: Flat Icon

Disclaimer

IIPRD has prepared this sample report, wherein contents of the report is based on internal evaluation of Patent Literature (Patents or Patent Applications) as retrieved from Patent Databases that are believed to be reliable by IIPRD. Being a sample report, a complete list of patent documents retrieved/analyzed is not disclosed herein; however, it can be made available on request, subject to IIPRD terms and conditions though. IIPRD disclaims all warranties as to the accuracy, completeness, or adequacy of the report. For preparing the report, patent literature searches (based on the keywords, IPC/CPC, etc.) were conducted and a dataset was retrieved, the dataset was then analyzed. The searching and analysis are subject to individual/researcher discretion, neither IIPRD nor its affiliates, any of its proprietors, and employees (together, "personnel") are responsible for the authenticity of the data. The purpose of this report is not to formulate any sort of legal advice.

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