Patent Landscape Report on

Solar Cooking

2011

PATENT LANDSCAPE REPORTS PROJECT

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

The WIPO patent landscape report project is based on the Development Agenda project DA_19_30_31_01 "Developing Tools for Access to Patent Information" described in document CDIP/4/6, adopted by the Committee on Development and Intellectual Property (CDIP) at its fourth session held from November 16 to November 20, 2009.

The purpose of each report is three fold:

- It attempts to research and describe the patterns of patenting and innovation activity related to specific technologies in various domains such as health, food and agriculture, climate change related technologies, and others.
- WIPO attempts to collaborate for each report with institutional partners (IGOs, NGOs, public institutions of Member States) working in the respective field and having an interest in a specific topic. The collaborative work in the planning and evaluation phases may also serve as a vehicle for these institutions to familiarize themselves with the utilization and exploitation of patent information and related issues of patent protection. WIPO welcomes proposals for collaboration.
- Each report also serves as an illustrative example for retrieving patent information in the respective field and how search strategies may be tailored accordingly. It therefore includes detailed explanations of the particular search methodology, the databases used and well documented search queries that should ideally enable the reader to conduct a similar search.

Each report of this project is contracted out to an external firm selected in a tendering procedure. The tender is open to a limited number of bidders that were pre-selected based on their submission of an Expression of Interest (EOI). WIPO invites the submission of further EOIs by qualified providers.

More Information on the project, the ongoing work, and a compilation of reports published also by other institutions is available at: *www.wipo.int/patentscope/en/programs/patent_landscapes/pl_about.html*

For specific information, requests or proposals, please contact us at: patent.information@wipo.int

PATENT LANDSCAPE REPORT ON

SOLAR COOKING

PREPARED FOR

WORLD INTELLECTUAL PROPERTY ORGANIZATION (WIPO)

BY

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1.0 Introduction

The present patent landscape report is based on WIPO's Development Agenda project DA_19_30_31_01 ("Developing Tools for Access to Patent Information") described in document CDIP/4/6 adopted by the CDIP at its fourth session held from November 16 to November 20, 2009. In the context of this approved project, WIPO is preparing 12 patent landscape reports in the biennium 2010-2011. These patent landscape reports are envisaged to become in future a standard service of WIPO in the context of improved access to and exploitation of patent information.

Patent landscape reports of the aforementioned DA project aim to contribute, by focusing on particular technological fields, to highlight essential technologies, know-how, processes and methods that are necessary to meet the basic development needs of developing countries, particularly with regard to improving the environment, life, health of human beings, animals, plants and food security. In a broader context, each specific report may also serve as an exemplification for retrieving and utilizing patent information. In this context, this report focuses on the solar cooking technology landscape.

2.0 Background

Solar energy is the most important non conventional source of energy because of its non-polluting nature. Solar cooking is the simplest, safest and most convenient way to cook food without consuming any fuel or heating up the cooking appliances which use solar energy to cook or bake the food. Solar energy is the most readily available free source of energy. Solar energy production can be divided into two types: solar thermal energy and photovoltaic power production. Among these two methods, solar thermal technology converts solar energy into thermal energy for use. The solar thermal energy thus obtained is mainly used for solar cooking which further includes other applications such as solar home heating, indirect electricity generation etc.

Solar cooking provides a very cost-efficient and environment-friendly solution foremost to rural communities of developing countries.

Purpose of the report

This report seeks to provide a comprehensive overview of available technologies in the solar cooking landscape including types of radiation collectors / types of cooking and heating methodology etc.

This report also aims to identify systems that are simple and easy to use in environments of rural communities in developing countries, preferably systems that could be used in individual households.

3.0 Research Focus

The main objective of this assignment was to conduct a "Patent landscaping analysis" on Solar Cooking to identify patent documents (includes granted patents, published patent applications, utility models) that exclusively disclose technologies / methods / processes / system and / or its components (e.g. radiation collectors, reflectors, heat conduction and storage, temperature control) of solar energy radiation that use as the primary energy source for cooking / baking / boiling / pasteurizing food without consuming any other alternative sources.

Furthermore, the analysis also sought to cover any patent family members that disclosed details pertaining to solar cooking methods or system or components in alternative or selective embodiments, which would bind up in one of the solar technology applications. In addition, the analysis should also cover commercially available products in the market that pertaining to a complete solar cooking system.

3.1 Databases/Resources used

The following patent and non-patent databases/resources were used to execute the assignment:

Patent Databases

Paid Databases

- Thomson innovation (http://www.thomsoninnovation.com)
- Patbase (http://www.patbase.com/login.asp)
- Micropat (http://www.micropat.com/static/index.htm)

Free Databases

- Free patents online (http://www.freepatentsonline.com/search.html)
- USPTO (http://patft.uspto.gov/netahtml/PTO/search-adv.htm)
- esp@cenet (http://worldwide.espacenet.com/advancedSearch?locale=en_EP)
- WIPO (http://www.wipo.int/pctdb/en)
- IPO (http://www.ipindia.nic.in/ipirs1/patentsearch.htm)
- PAJ (http://www19.ipdl.inpit.go.jp/PA1/cgi-bin/PA1INIT?1175358331875) (Patent Abstracts of Japan)
- Google Patents (http://www.google.com/advanced_patent_search)
- PatentLens (http://www.patentlens.net/patentlens/structured.html)
- Wikipatents (http://www.wikipatents.com/advsearch)

Non-patent Databases / Resources Used for Product Identification

- Google (http://www.google.com)
- Solar Cookers International (SCI) (http://solarcookers.org)
- Terra Foundation (http://www.terra.org/cocinas/directorioen.php)
- Solar Oven Society (http://www.solarovens.org)
- Solar Cooker-at-Cantinawest.com (http://www.solarcooker-at-cantinawest.com)
- Solar Household Energy, INC. (http://www.she-inc.org)
- Alibaba.com (http://www.alibaba.com)
- e-Bay.com (http://www.ebay.com)
- Amazon.com (http://www.amazon.com)
- Indiasolar.com (http://www.indiasolar.com)
- Solarcooking.wikia.com (http://solarcooking.wikia.com)
- Build it solar (http://www.builditsolar.com)
- Solaripedia (http://www.solaripedia.com)
- Major solar cooker manufacturing companies like
  - Sunoven.com (http://www.sunoven.com)
  - Soltac.com (http://www.soltac.com)
  - Beijing WiSword Hi-Tech.Development Co.Ltd etc. (http://wisword.en.ecplaza.net)

3.2 Tools used for statistical analysis

The following tools were used to execute the assignment:

- Scope's internally developed tools including macros
- MS-Excel
- MS-PowerPoint

3.3 Patent Coverage

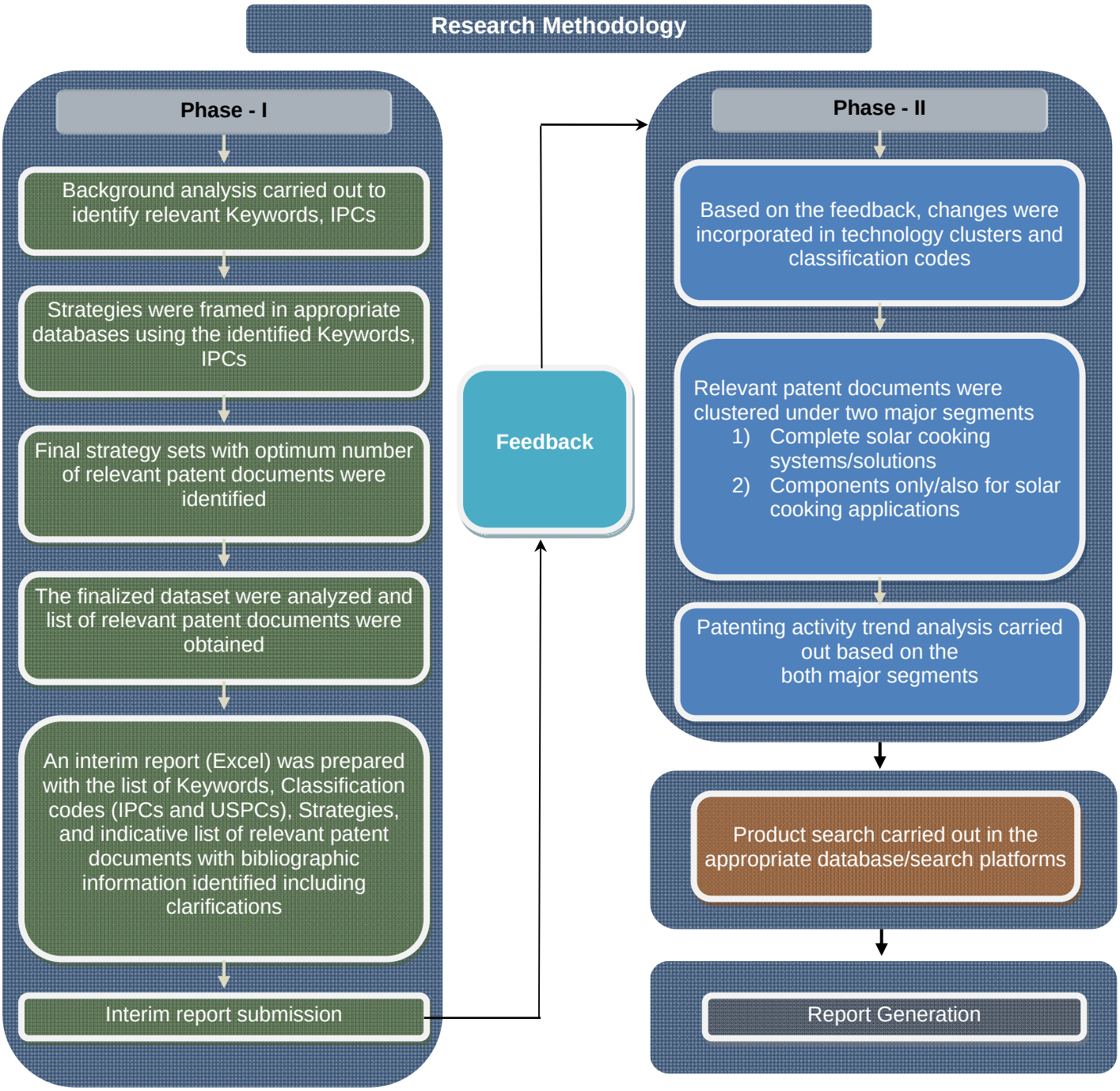
The scope of patent coverage included the following authorities:

- United States of America (US)
- United Kingdom (GB)
- Japan (JP)
- Europe (EP)
- PCT (WO)
- 41 countries covered in Derwent World Patents Index (DWPI)*

Note: All Non-English patent documents (including DE, FR, KR, CA, CN and other 30 countries) that didn't have any family members in US, GB, JP, EP, and WO have been covered using the paid service DWPI. These patent collections covered by "DWPI" were analyzed based on the Derwent abstract. However, the claims of the relevant documents obtained from the Derwent abstract analysis were further analyzed using EPO (Espacenet), based on the availability of the English content in the EPO.

4.0 Research Methodology

The assignment was carried out in two phases, all inter-related in order to meet the objective of the assignment. The two phases are explained below in detail:



Keyword identification and Strategy framing:

The patent landscape search was performed using a variety of search modes such as keywords search, classification codes search and combinational searches along with the keywords and codes. All the relevant keywords and their synonyms were identified for solar cooking technology. Further, the relevant classification codes were identified by looking at the relevant keywords in the catchword index of the International Patent Classification (IPC), Index to the U.S. Patent Classification System (USPCS) or European classification (ECLA). In addition, classification codes were also retrieved by running a keyword search in the relevant patent databases.

Strategies were framed from the identified keywords and/or classification codes in the appropriate patent databases using suitable Boolean and Proximity operators*. The strategies with an optimum number of relevant patent family members were considered for further analysis.

*Note: * Words such as AND, OR, and ANDNOT that are called "Boolean/logical operators" and words such as ADJ, NEAR, WITH and SAME are called "Proximity operators", and are used to combine search terms to either broaden or narrow the results of a search. Boolean Searching describes the method of searching in which terms are combined to either recall more documents or to retrieve a more precise set of documents. (http://www.wipo.int/pctdb/en/glossary.jsp#r)*

Family Reduction Process:

In order to avoid analyzing the same invention filed in different countries, a patent family** reduction process was carried out using the Thomson innovation database. During the process, any one member which has been published in English (preferably a PCT publication number if available) were considered as representative member of the respective family, and the same was used for further analysis.

*Note: ** A group of patent equivalents relating to a specific invention make up a patent family. Members of a closely-related patent family have a common priority application number and date. Extended patent family members typically result from complex relationships but sharing at least one common priority application from different countries. Or extended patent family members may relate to relationships resulting from divisions, continuations, or continuations-in-part. (http://www.wipo.int/pctdb/en/glossary.jsp#r)*

Patent Analysis:

The family reduced datasets were screened out to select the relevant patent documents (including granted patents, published patent applications and utility models). Subsequently, the screening process identified all the relevant patent documents that disclose about methods/ processes / operation / devices / components for solar cooking application in either specific or wider context.

Product Identification:

A separate product search was also carried out to identify commercially available products in the market for the obtained patent documents through research of online resources such as solar cooking community web links. Furthermore, the major inventors and assignees related web links were analyzed.

5.0 Research Summary

A comprehensive search was executed in the appropriate patent databases based on the above mentioned methodologies with identified keywords and classification codes related to the solar cooking technology. The strategies were framed in different combinations as follows:

- Only with Keywords: 37, 634
- Using classification codes
    - Using IPC F24J000200 alone: 33,412
    - Using USPC 126/681 alone: 113
- Combination of keywords and classification codes: 2,977

Note: Reference - Annex I (Strategies used)

The strategies were combined to remove duplicates which resulted in 5,261 patent documents, and the retrieved dataset further reduced to one member per family for analysis i.e. 3,378 patent family members. The representative member of each patent family (mention of which member was considered as “representative” to be found under “Assumptions and limitations”) will onwards be mentioned in the report as “patent family”.

Furthermore, the analysis revealed 573 patent families as relevant to solar cooking technology after the elimination of irrelevant patent families. Among the relevant patent documents, 397 patent families were categorized under the “Complete solar cooking systems/solutions” segment (refer to the attached spreadsheet) based on the entire arrangement /mechanism, which were further clustered based on the heating methods and components involved.

Furthermore, the remaining 176 patent families were categorized under the “Components only/ also for solar cooking applications” segment (refer to the attached spreadsheet) as they particularly pertain to components used in solar cooking application and components/ methods used in solar energy application including solar cooking. These patent family members were further clustered based on different types of components / accessories disclosed.

Details of Spreadsheet attached:

Sheet 1: Complete solar cooking systems/solutions

This sheet contains a list of 397 patent family members (hyperlinked), with their bibliographic data*** and technology cluster details.

*Note: *** The term "bibliographic data" refers to the various data elements that normally appear on the first page of a patent document or the corresponding applications. Such data comprise document identification data, domestic filing data,*

priority data, publication data, classification data and other concise data relating to the technical content of the document or of the entry in the official publication. (http://www.wipo.int/pctdb/en/glossary.jsp#r)

Sheet 2: Components only/also for solar cooking applications

This sheet contains a list of 176 patent family members (hyperlinked), with their bibliographic data and technical cluster (components) details.

Sheet 3: Solar Water Heater

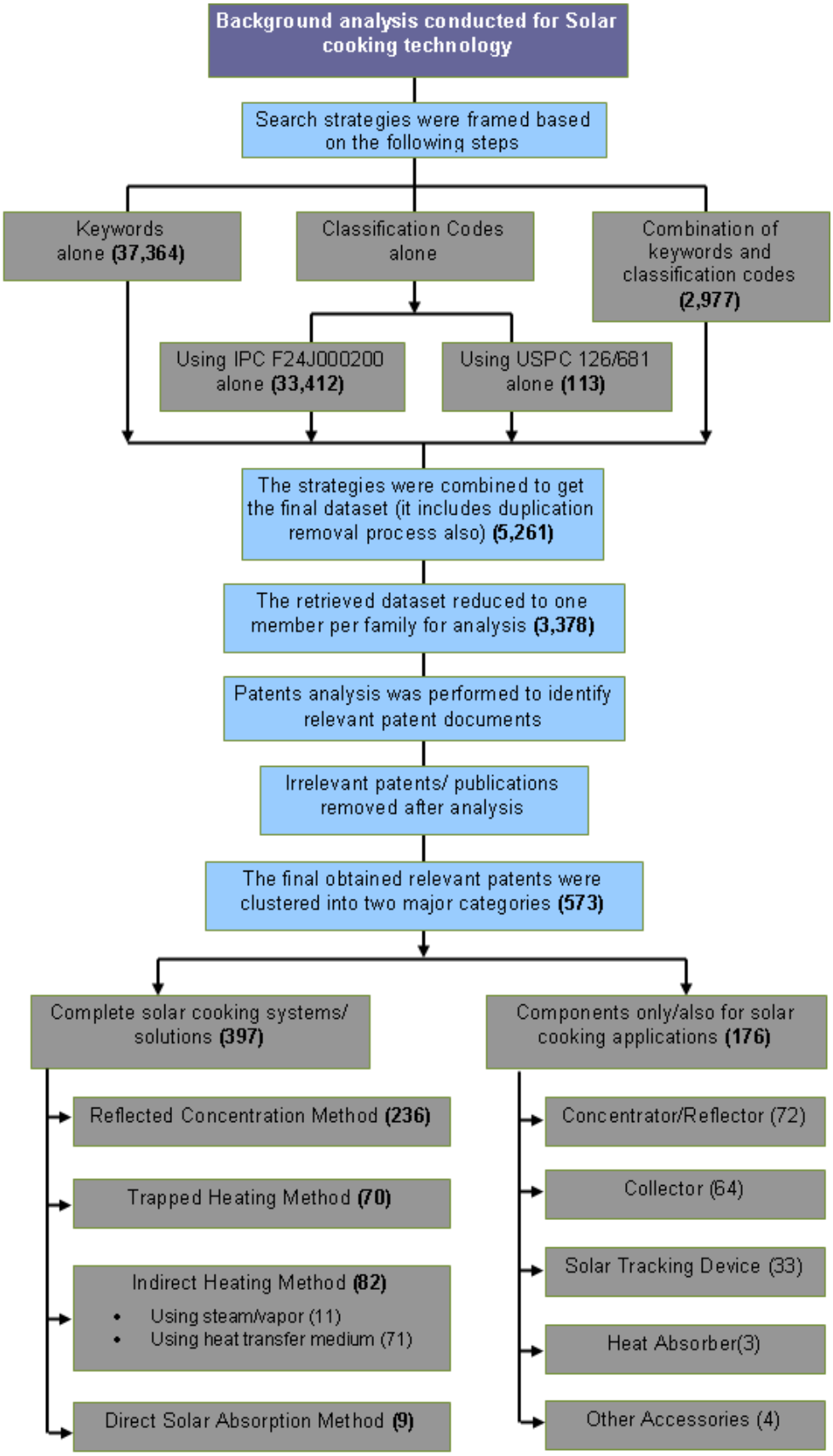
This sheet contains list of 165 patent family members, with their titles. These patent family members exclusively disclose water heating methodologies and not about any other cooking process. This segment was thus excluded from the detailed analysis since this is not part of the scope of the assignment.

Sheet 4: Patent documents with title alone

This sheet contains list of 48 patent family members, with their titles alone.

Note: The research yielded 165 patent family members that disclosed solar water heating as predominant feature. Further the research yielded 48 patent family members with only title field (abstract, description, illustration not available) which were also not considered for analysis. These patent family members have been listed separately for your reference.

Process flow diagram:



5.1 *Research Synopsis*

A landscape study was conducted to identify the patenting activity in the solar cooking technology. The analysis revealed patent family members that discussed specifically complete solar cooking or its components.

The obtained patent family members were broadly classified into two major segments

- Segment I - Complete solar cooking systems/solutions
- Segment II - Components only/also for solar cooking applications

"Segment I" mainly comprises patent family members that were clustered primarily based on heating techniques like reflected concentration, trapped heating, indirect heating (using steam/vapor cooking or using heat transfer medium) and direct solar absorption. Furthermore, they were sub clustered under different components like concentrator/reflector, solar tracking device, heat absorber, heat storage, heat trap, insulation and other accessories.

"Segment II" comprises patent family members that were clustered primarily based on different types of components only/also used for solar cooking applications, whereas the components include concentrator/reflector, collector, solar tracking device, heat absorber and other accessories.

Wherein:

- Concentrator/reflector mainly used to concentrate/reflect the solar energy into to cooking surface, collector arrangement used to collect heat by absorbing solar light,
- Heat absorber used to effectively absorb the solar energy and retain the heat for some time, insulator used to retain the heat within the cooking surface / chamber and
- Solar tracking device used to track and adjust the cooking surface inline with sun
- Heat storage device used to store the absorbed solar energy for future use

Graph 1: Major segments of Solar Cooking Technology

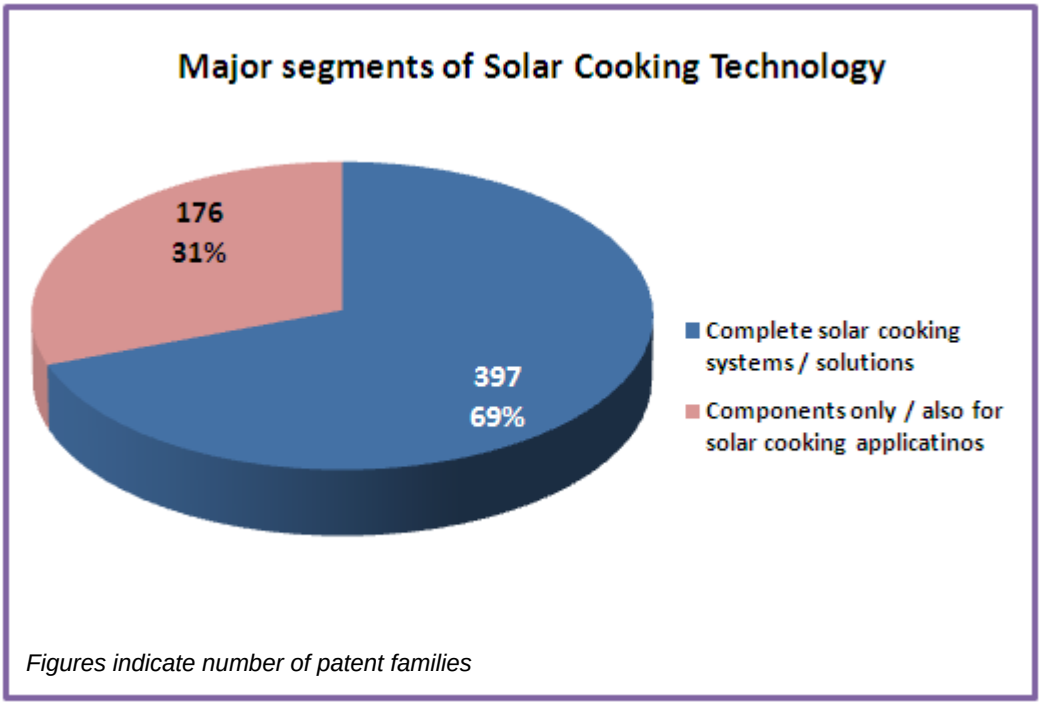


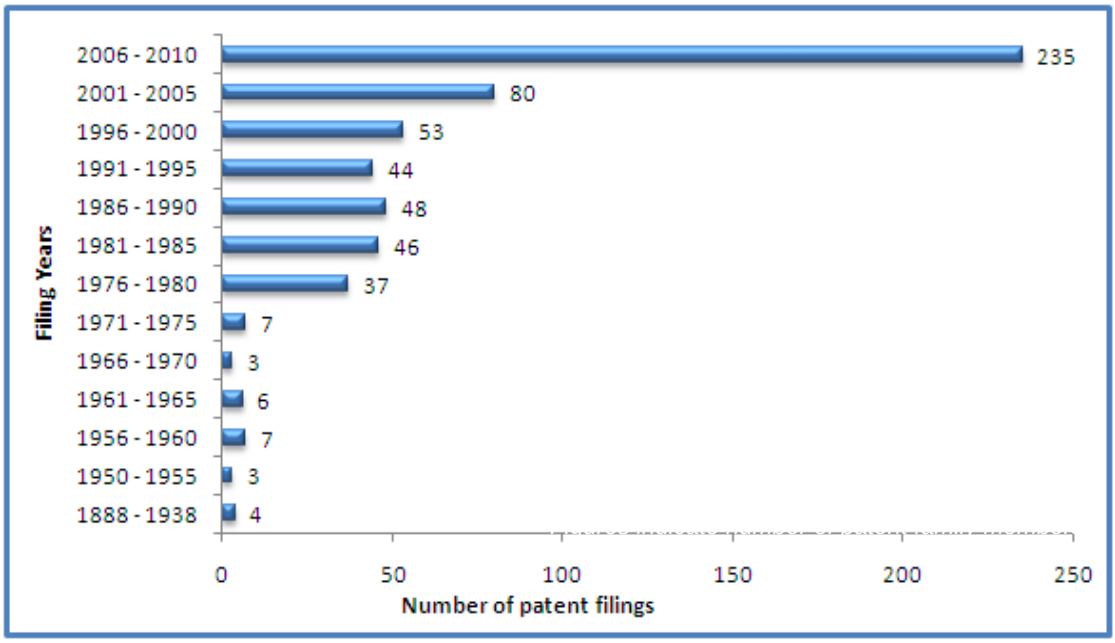
Table 1: Definitions

Cluster	Definition
Major Segments	
Complete solar cooking systems/solutions	Inventions pertaining to arrangements / assemblies / components / methods / working procedure, particularly used for solar cooking, whereas all the inventions are figuratively representing the solar cooker.
Components only/also for solar cooking applications	Inventions pertaining to components used for solar cooking application and arrangements / assemblies / components / methods / working procedure for solar technologies in variety of applications (e.g. space communication, improved solar concentrator, light wells for buildings, beam splitters, and ultrasonic lenses), whereas one of the application includes cooking.

5.2 *Overall Patenting Trend Analysis in the Solar Cooking Technology Landscape*

An analysis for filing years revealed that patenting activity pertaining to the solar cooking technology space was spread across the years starting from 1888 to 2010. In fact, the first filing started in the 19th century itself. It was in the mid-70s' (1976) that patenting activity began to grow on a sustained basis. From 1976 to 1999, there were 207 patent applications filed and this activity grew rapidly post the millennium with about 334 patent filings. In fact, over the last four-year period (2006-2010), a total of 235 patent applications have been filed.

Graph 2: Overall Patenting Trend Analysis in the Solar Cooking Technology Landscape



An in-depth patenting trend and technical analysis was carried out separately for the two major segments viz. i) Complete solar cooking systems/solutions and ii) Components only/also for solar cooking applications and is discussed in detail below

6.0 Segment I – Complete solar cooking systems/solutions

Summary

Table 2: Summary on complete solar cooking systems/solutions

Major Segment	Segment I
Segment title	**Complete solar cooking systems/solutions**
Total number of patent family members (inventions)	**397**

Primary clusters	**Solar energy collection & heating techniques**
	• Reflected concentration
	• Trapped heating
	• Indirect heating
	  ➢ Using heat transfer medium
	  ➢ Using steam / vapor
	• Direct solar absorption

Sub clusters	**Concentrator/Reflector** • General • Glass • Mirror • Lens • Reflective coating materials • Foils / Sheets • Other / combinational materials **Solar Tracking Device** • Automatic • Manual **Heat Absorber** • General • Absorber plate • Polymer/dark surface coatings • Polymer/dark coating over pots/tube/vessels **Heat Storage** • Devices (e.g. Vessel or reservoir with heat pump)

Major Segment	Segment I
	• Phase change materials PCM **Heat trap** **Insulation** **Other Accessories**

Cluster Definitions

Table 3: Definitions

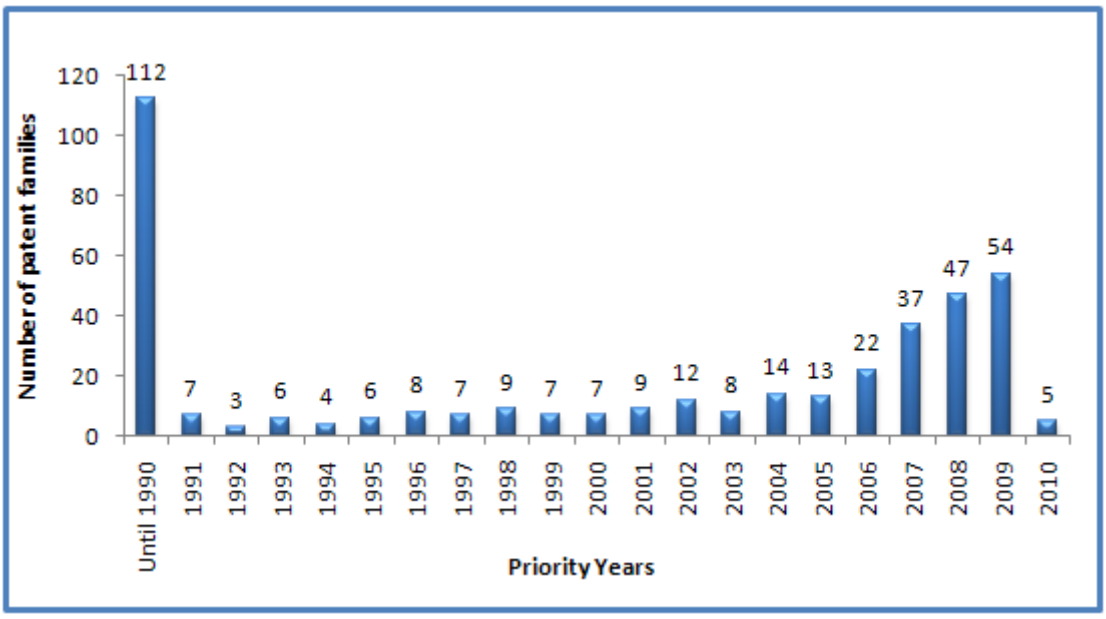
Cluster	Definition
Solar Energy Collection & Heating Techniques	
Techniques/methods adopted for reflecting/concentrating solar radiation so as to make them useful for cooking food	
Reflected concentration	In the reflected concentration method, multiple surfaces reflect sunlight on to a single area of concentration. Any concave surface or a group of glass panels arranged in such a manner are used to concentrate the reflected sunlight onto the cooking surface
Trapped heating	In this method, the reflected/concentrated sunlight is not radiated out back from the cooking vessel and is therefore trapped within the cooking vessel enclosure, which provides a green house effect to the entire cooking system
Indirect heating	In this method, solar heat is physically displaced from the collector and a heat transferring medium is used to convey the heat to the cooking pot. The indirect heating of food can be carried out by i) converting a liquid into steam and then using the steam to cook the food; ii) using a heat transfer/conducting medium which conducts the solar heat and gets heated, which is then circulated to the food to be cooked.
Direct solar absorption	Cooking of food by directly absorbing the heat from sun light and passing it to the food or vessel without any means of reflection or storage.
Concentrator/Reflector	
Solar concentrators / reflectors direct solar energy onto the absorber area for producing sufficient heat energy for cooking. Reflectors directly reflect the gathered solar radiation over the absorber area whereas concentrators gather radiation over a large area and focus it onto a small absorber area.	
General	Concentrator / reflector arrangements, reflective surfaces to concentrate solar radiation to a focal point to be heated.
Glass	Concentration of light is achieved with the help of glass.
Mirror	Concentration of light is achieved using mirrors (reflection)
Lens	Concentration of light is achieved using transparent lens (refraction)
Reflective coating materials	Different reflecting materials coated on the surface of the materials such as cardboard, glass surfaces useful for reflecting/concentrating solar radiation.
Foils / Sheets	Concentration of light is achieved using aluminium foil, silver foil, etc.,
Other / combinational materials	Concentration of light is achieved with the help of other materials that are not specified above or with the combination of above said materials

Solar / Sun Tracking	
Devices/arrangements of solar cooker which are used to track/follow the sun throughout the day regardless of its location or angle and to align with the cooker to focus the solar radiations accurately.	
Automatic	Automatic or electronically controlled tracking / turning mechanism that allows rotation of the reflector or cooking assembly either vertical or horizontal direction to focus the sunlight
Manual	The reflector position is controlled manually. This can be done using any mechanical means like using drive shaft or by means of manual tilting / rotation.
Heat Absorber	
Materials/components used to absorb the direct or reflected solar radiations and to convert them into longer wavelength heat energy and to radiate it from the interior materials.	
General	Absorber is usually composed of several narrow metal strips in a collector in which heat transfer fluid flows through a heat-carrying pipes or tubes, which are connected to the absorber strip
Absorber plate	In plate-type absorbers, two sheets are sandwiched together for allowing heat transfer fluid between the passages formed in the plates. The absorber is generally made of copper or aluminum.
Polymer/dark coating over pots/tubes/vessels	Black or dark surface coatings coated over the cooking pots/vessels for absorbing heat.
Polymer/dark surface coatings	Black or dark surface coatings coated in the inner portion/components such as reflectors, cooking chamber etc., for absorbing heat.
Heat Storage	
Device/materials used for storing and retaining the absorbed solar heat and utilizing absorbed heat for cooking in late evening/night time/off sunshine hours.	
Devices (e.g. Vessel or reservoir with heat pump)	Devices used for storing and retaining the absorbed solar heat
Phase change materials PCM	Types of materials used for solar heat storage.
Heat trap	
Heat trap device / material help to convert the absorbed light energy into longer wavelength heat energy with the help of materials within the enclosed space. Due to its longer wavelength, the heat energy is not radiated out back and is therefore trapped within the enclosed space.	
Insulation	
Insulation materials/devices allow minimal conduction of heat from the inner box structural materials to the outer box structural materials.	
Other accessories	
Other accessories like stands for supporting and adjusting solar ovens position or direction with respect to the sun, vessels / pots / other cooking apparatus used in solar cooker / solar cooking systems.	

6.1 Significant trends in Solar Cooking Patent Landscape Analysis

6.1.1 Patenting Activity over Priority years:

Graph 3: Patenting activity over priority years



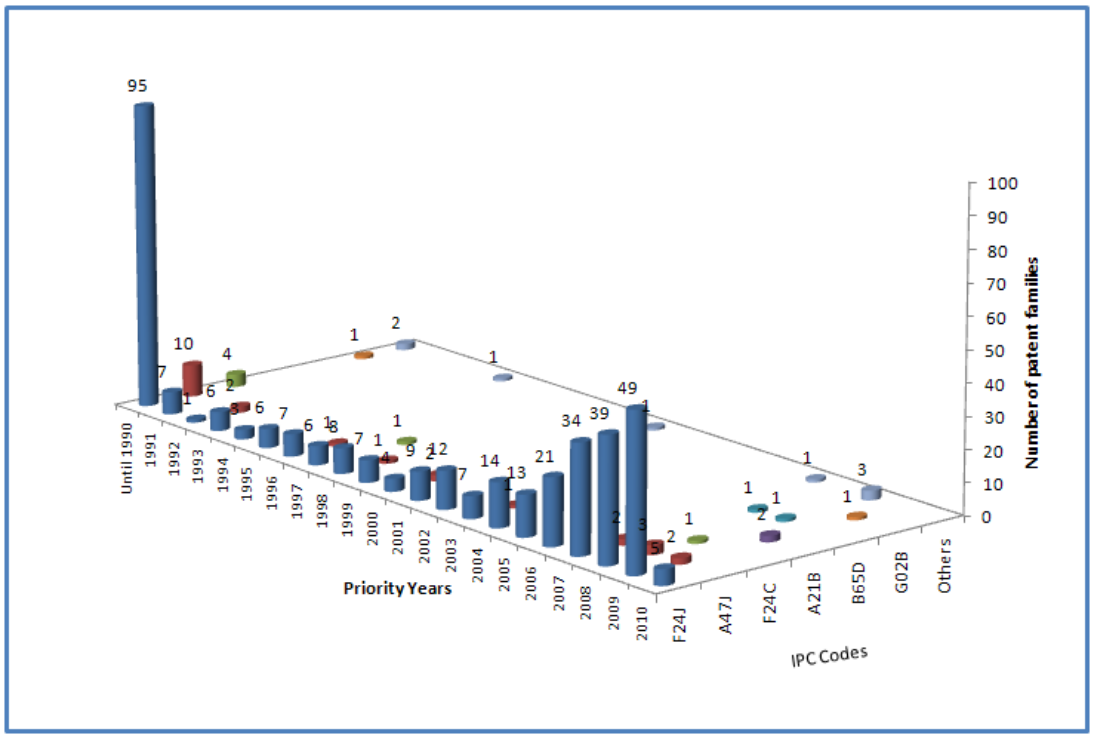
Patent Dataset: 397 patent families

An analysis of patenting activity pertaining to complete solar cooking systems revealed a total of 397 patent family members. Among these patent family members, almost 72% (285 patent inventions) were first-filed after 1990, while the patenting activity of the remaining 28% (112 patent inventions) started earlier in the 1880's. The highest patenting activity was recorded in the year 2009 with 54 patent inventions, followed by years 2008 and 2007 with 47 and 37 patent inventions respectively

The year 1992 witnessed the least patenting activity (first-filing) with only three patent inventions. However, patenting activity has gradually increased after 2003. During the last 20 years, namely between 1990-2010, about 285 patent inventions were filed.

6.1.2 IPC Analysis across Priority years:

Graph 4: IPC analysis across priority years



Patent Dataset: 397 patent families

Table 4: Definitions

IPC	IPC Definitions[1]
F24J	PRODUCTION OR USE OF HEAT NOT OTHERWISE PROVIDED FOR
A47J	KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES
F24C	OTHER DOMESTIC STOVES OR RANGES; DETAILS OF DOMESTIC STOVES OR RANGES, OF GENERAL APPLICATION
A21B	BAKERS' OVENS; MACHINES OR EQUIPMENT FOR BAKING
B65D	CONTAINERS FOR STORAGE OR TRANSPORT OF ARTICLES OR MATERIALS, e.g. BAGS, BARRELS, BOTTLES, BOXES, CANS, CARTONS, CRATES, DRUMS, JARS, TANKS, HOPPERS, FORWARDING CONTAINERS; ACCESSORIES, CLOSURES, OR FITTINGS THEREFOR; PACKAGING ELEMENTS; PACKAGES
G02B	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS

[1] http://www.wipo.int/ipcpub/

An analysis of the leading primary IPCs pertaining to the complete solar cooking field identified six top IPCs having at least two patent family members. The six leading IPCs accounted for almost 98% (389 patent family members) of the 397 patent family members.

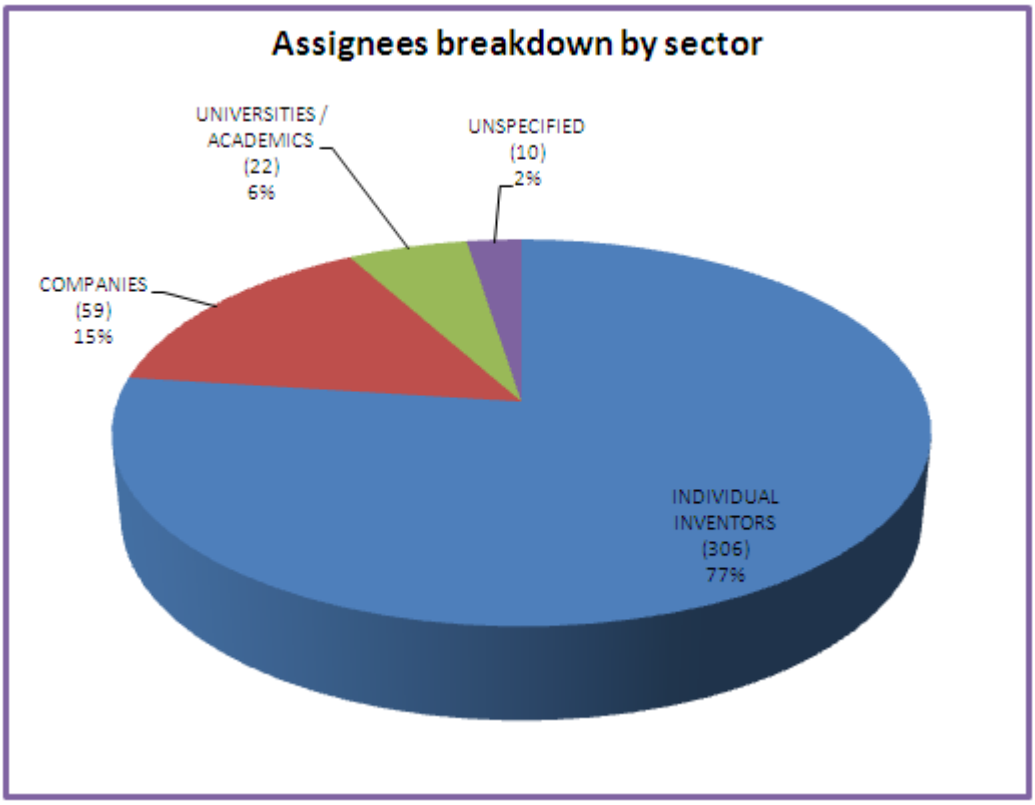
IPC (primary) F24J (PRODUCTION OR USE OF HEAT NOT OTHERWISE PROVIDED FOR) leads the IPC list with 353 patent family members (or 89% of the total 397 patent family members), while 343 (97%) patent family members fall under the IPC (sub class) F24J 2/00 (Use of solar heat, e.g. solar heat collectors), and the remaining ten patent family members fall under other subclasses of F24J.

IPC (primary) A47J (KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES) was the second leading IPC code with 24 patent family members (or 6% of the total 397 patent family members), followed by IPC (primary) F24C (OTHER DOMESTIC STOVES OR RANGES; DETAILS OF DOMESTIC STOVES OR RANGES, OF GENERAL APPLICATION) was with six patent family members (or 2% of the total 397 patent family members)

IPCs (primary) A21B (BAKERS' OVENS; MACHINES OR EQUIPMENT FOR BAKING) and B65D (CONTAINERS FOR STORAGE OR TRANSPORT OF ARTICLES OR MATERIALS, e.g. BAGS, BARRELS, BOTTLES, BOXES, CANS, CARTONS, CRATES, DRUMS, JARS, TANKS, HOPPERS, FORWARDING CONTAINERS; ACCESSORIES, CLOSURES, OR FITTINGS THEREFOR; PACKAGING ELEMENTS; PACKAGES) and G02B (OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS) topped the remaining three leading IPC categories with two patent family members each.

6.1.3 Assignee Analysis

Graph 5: Assignees breakdown by sector

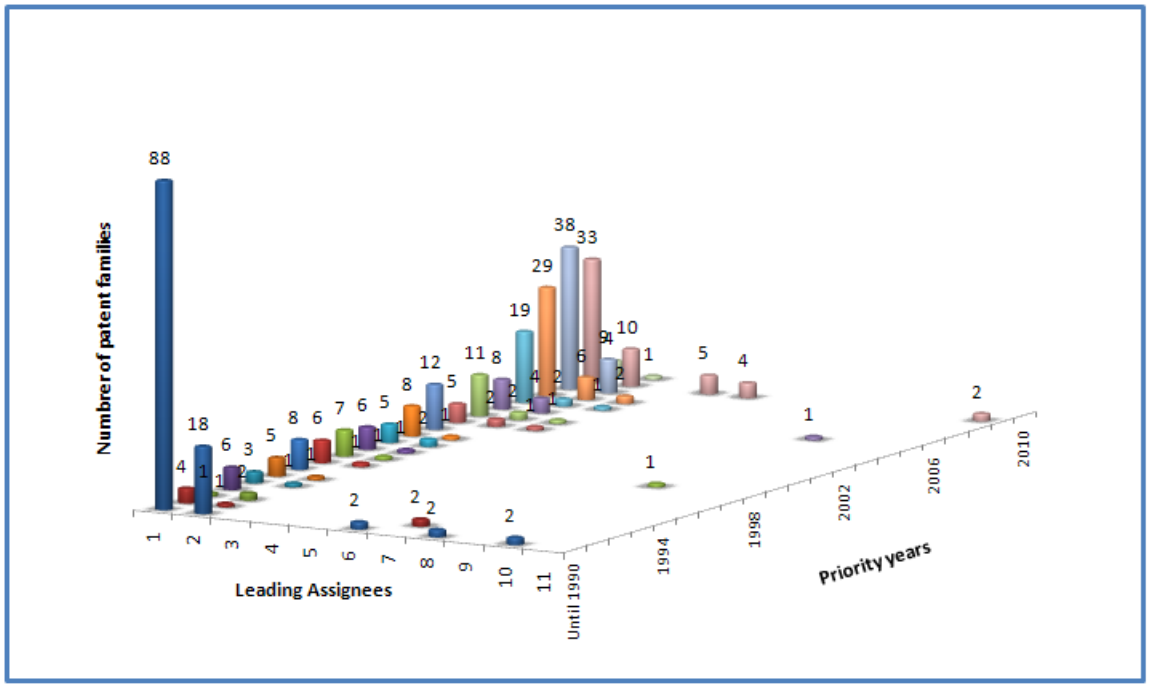


Patent Dataset: 397 patent families

At the overall level, 306 patent family members related to complete solar cooking systems were held by individual inventors contributing to a dominating 77% of the total 397 patent family members. This category was followed by Technology related companies with 15% (59 patent family members) of overall patent family members. Universities/Academics/Research Institutes contributed only 5% (22 patent family members) of the entire 397 patent family members, whereas the remaining 3% (10 patent family members) of the assignees were unspecified (none).

An overall assignee analysis revealed that Individual inventors' have the most active participation in "complete solar cooking systems", whereas Companies and Research & Academia do not seem to show high interest in this area.

Graph 6: Assignees activity across priority years-Leading Assignees Vs Priority years



Patent Dataset: 397 patent families

1	Individual inventors
2	Other assignees
3	Beijing hebaiyi ecology energy sources technology development co ltd
4	Beijing wisword hi tech co ltd
5	Zhuhai double happiness electric appliance co ltd
6	Agency of industrial science and technology
7	Beijing energy-saving technology service centre
8	Curtiss-wright corp
9	Industrial technology research institute
10	Univ of sydney
11	W&E international (canada) corp

From 1880 until 1990 there were 112 first filed inventions, among which a majority of 88 patent family members are held by individual inventors. An analysis of the overall assignees identified eight leading assignees holding more than two patent family members. These leading assignees contributed only 6% (24 patent family members) to the 397 patent family members. As indicated earlier, individual inventors dominated the portfolio with a 77% (306 patent family members) share of overall patent family members. All the remaining assignees having single patent family member contributed 17% (67 patent family members) of the 397 patent family members.

Among the eight leading Assignees, four were companies that have first-filed inventions, whereas the remaining four come from the area of Research and Academia. "BEIJING HEBAIYI ECOLOGY ENERGY SOURCES TECHNOLOGY DEVELOPMENT CO LTD" and "BEIJING WISWORD HI TECH CO LTD" shared the overall lead in the assignee list with five patent family

members each. A significant point to note is that all of their inventions were first-filed after 2002. "ZHUHAI DOUBLE HAPPINESS ELECTRIC APPLIANCE CO LTD" was at the third position with four patent family members, all of which were first-filed in 2009.

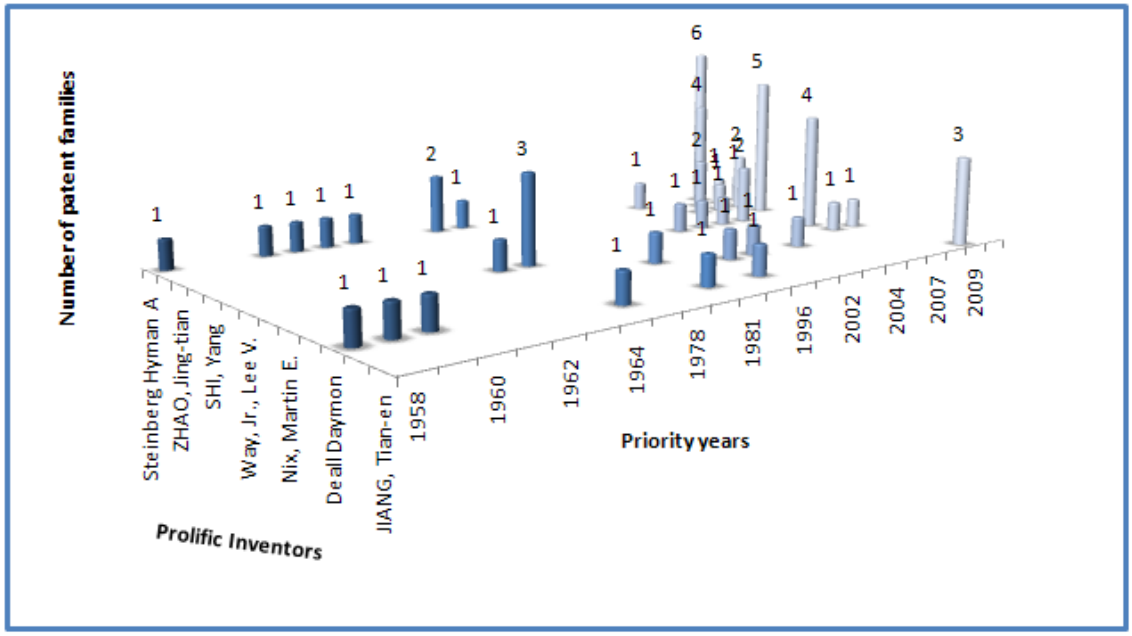
The remaining leading assignees "AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY", "BEIJING ENERGY-SAVING TECHNOLOGY SERVICE CENTRE", "CURTISS-WRIGHT CORP", "INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE", "UNIVERSITY OF SYDNEY" and W&E INTERNATIONAL (CANADA) CORP had two patent family members each.

The highest patenting activity (first-filing) was observed in the year 2009 with 54 patent family members, which accounts for 14% of the overall 397 patent family members. Furthermore, two of the leading assignees, namely "BEIJING WISWORD HI TECH CO LTD" and "ZHUHAI DOUBLE HAPPINESS ELECTRIC APPLIANCE CO LTD" had an overall of nine first filings in 2009.

Among the leading assignees', majority of them were Chinese companies. While they do figure as part of the leading assignees list, their presence in the "complete solar cooking systems" category was nevertheless less prolific when compared to that of Individual inventors' contribution.

6.1.4 Prolific Inventor Analysis

Graph 7: Prolific inventor analysis



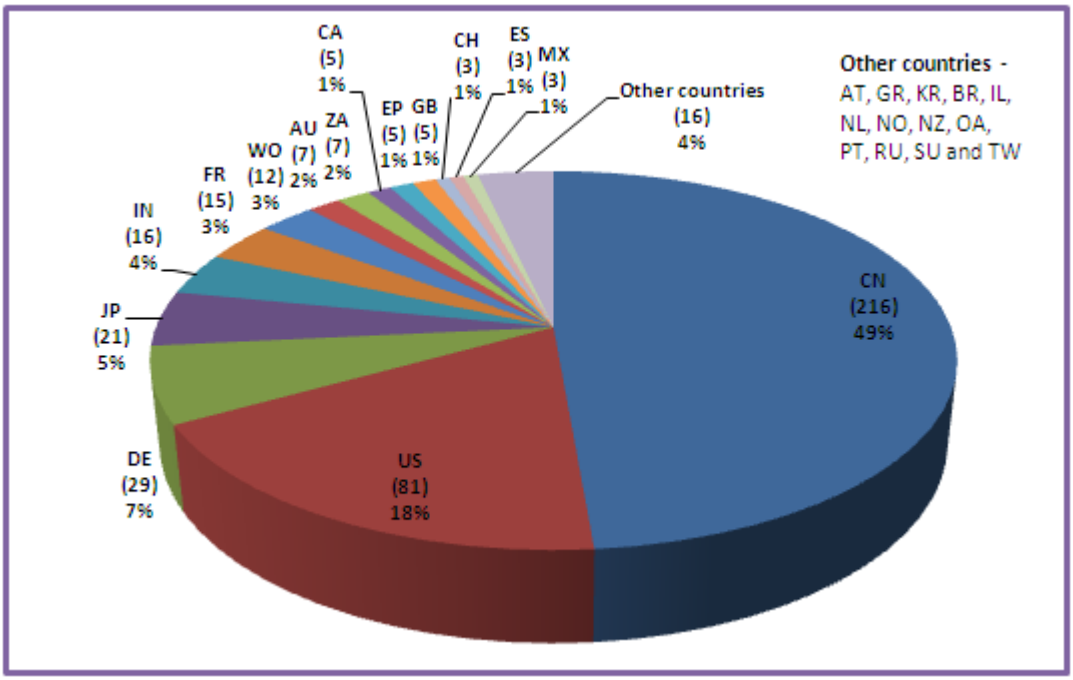
Patent Dataset: 397 patent families

An analysis of the inventors of the 397 patent family members identified about 12 prolific inventors having at least three patent family members. STEINBERG HYMAN was the leading inventor with eight patent inventions which were filed in the period 1950-1980. LI JIAN-MIN was the second leading inventor, involved in seven patent inventions, six out of which were filed in 2009. ZHAO JING-TIAN was the third leading inventor, involved in six patent inventions; four out of which were filed in the year 2008.

Inventors XIN YA-NAN, SHI YANG and YAN KAI were the next leading inventors with each of them having five patent family members. WAY JR. LEE V. and ZHAO KE-XUE involved in four patent family members each and NIX MARTIN E, KOCH CHRISTIAN, DEALL DAYMON, ERWIN SAMUEL F and JIANG TIAN-EN having three patent family members each completed the prolific inventors list.

6.1.5 Geographical distribution

Graph 8: Geographical distribution



Patent Dataset: 444 granted patents, published patent applications, utility models

An analysis of the geographical distribution of the 397 patent family members (or 444 patent/applications) related to complete solar cooking systems revealed the following:

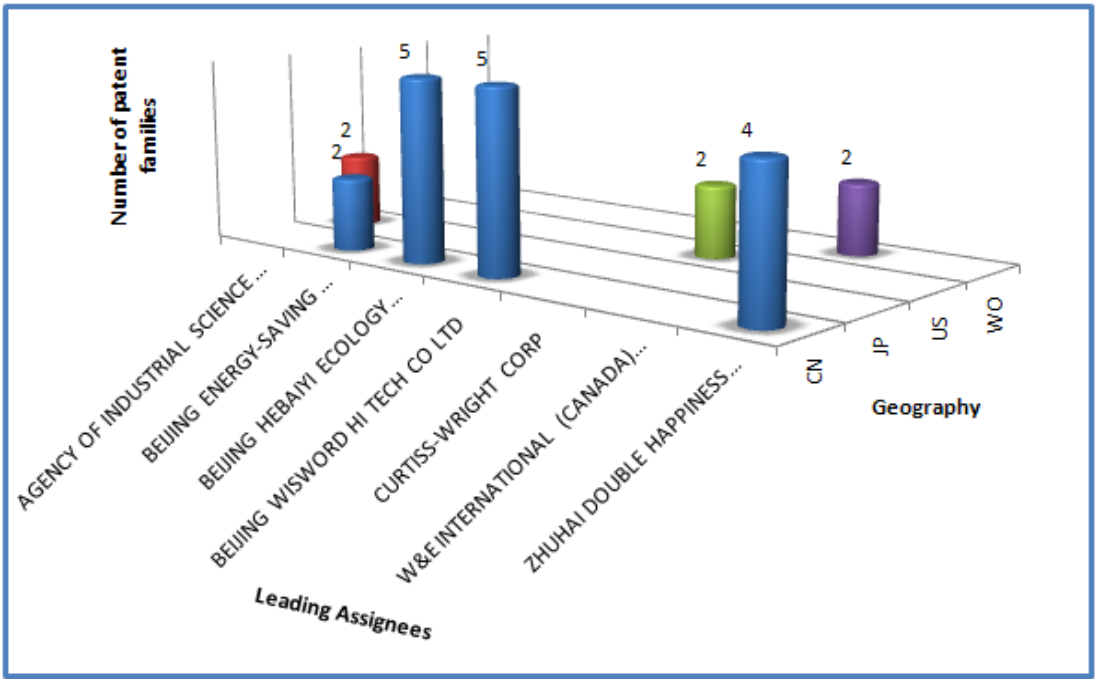
A maximum of 49% (216 patents / applications) of the 444 patents/applications were published in China (CN). Among them, utility model related patents dominate with a share of 78% of overall filings (169 patents / applications).

The United States (US) was the second leading country of origin contributing to 18% (81 patents / applications) of the 444 patents/ applications. Individual inventors filed more number of patents / applications than companies / universities in all patent authorities. Specifically in the US, individual inventors dominated the patent filings with 84% (68 patents / applications).

Germany (DE), Japan (JP), India (IN) and France (FR) were the other leading patent filing geographies with 29, 21, 16 and 15 patents / application counts respectively. Surprisingly, only 3% (12 PCT applications) of the overall patent filings were PCT applications.

6.1.6 Leading assignees across major patenting authorities

Graph 9: Leading assignees across major patenting authorities



Patent Dataset: 397 patent families

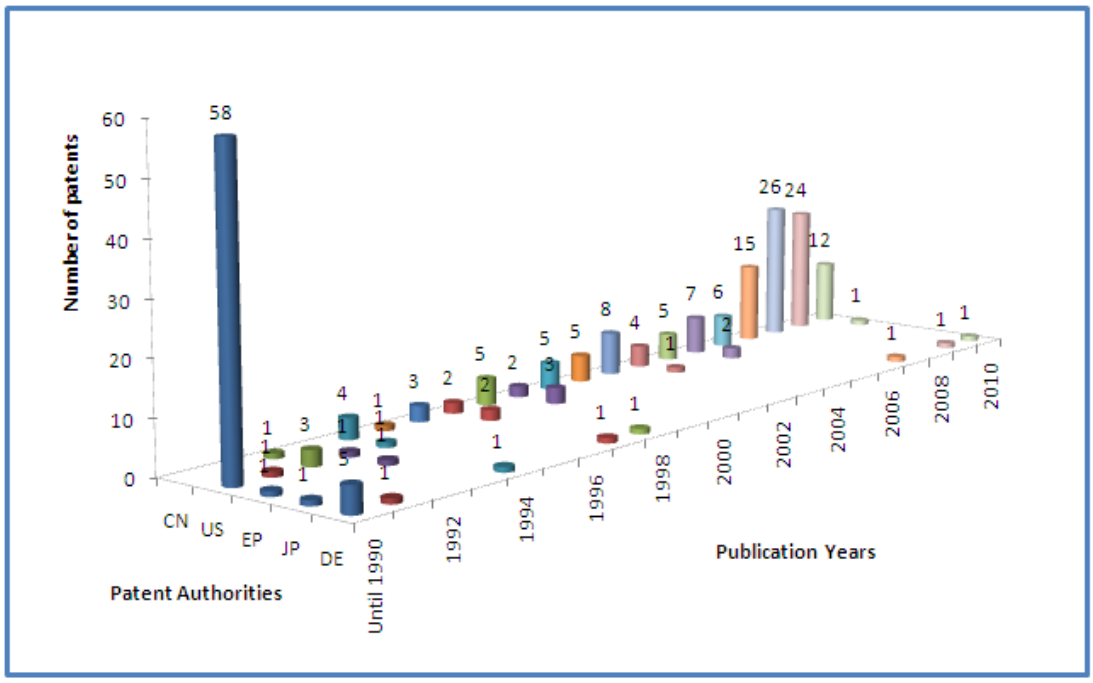
An assignee analysis based on the total number of patent filings made across major patenting authorities, namely CN, US, JP and PCT is discussed below. In the remaining major countries of filing IN, FR and DE, the number of patent filings held by individual inventors was higher than that of the other categories of patent assignees and hence, for the purposes of this analysis, these countries were not included.

In line with the overall trend, CN dominated the trend with a maximum number of top assignees. “BEIJING HEBAIYI ECOLOGY ENERGY SOURCES TECHNOLOGY DEVELOPMENT CO LTD” and “BEIJING WISWORD HI TECH CO LTD“ emerged as the top assignees with five patent filings each in CN. “ZHUHAI DOUBLE HAPPINESS ELECTRIC APPLIANCE CO LTD” and “BEIJING ENERGY-SAVING TECHNOLOGY SERVICE CENTRE” were the next top assignees with four and two patent filings respectively in the same country of first filing.

“AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY“(with two patent family members) and “CURTISS-WRIGHT CORP“(with two patent family members) were the sole assignees in the JP and the US geographies respectively, while W&E INTERNATIONAL (CANADA) CORP emerged as the sole player with PCT filings (two patent family members).

6.1.7 Patent Grant analysis across patent authorities and publication years:

Graph 10: Patent Grant analysis across patent authorities and publication years



Patent Dataset: 223 granted patents / utility models

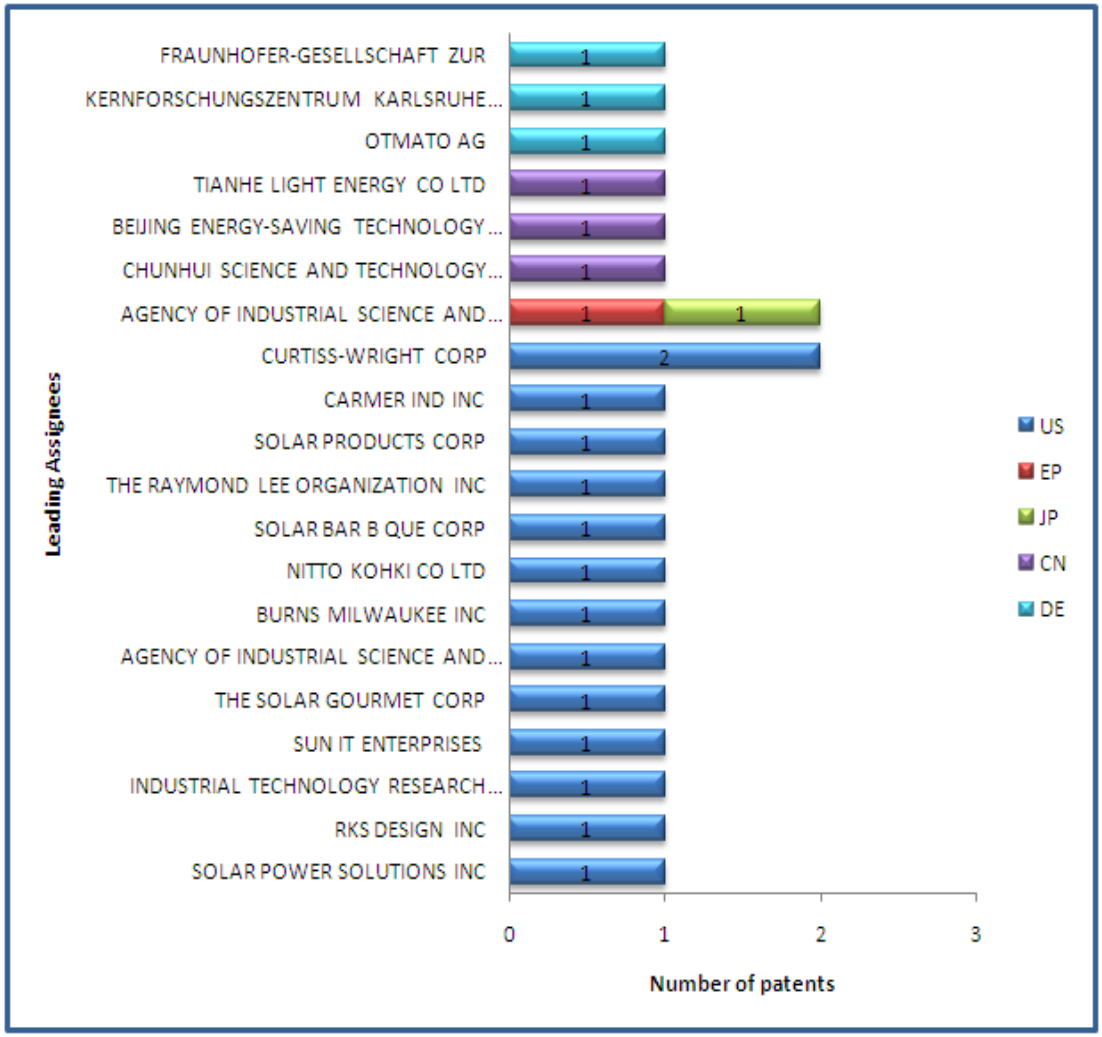
Among the 397 patent family members, 223 patent documents / utility models were granted in different patent authorities. 135 of them were granted / issued by the Chinese (CN) authority, thereby emerging as the leader (130 out of 135 being utility models and the remaining five patents having been published during 2006-2009).

73 patents were granted in the United States (US). Of these 73 patents, 58 were published before 1990, 11 patents were published during 1991 – 2000 and the remaining four patents were published after 2000

- 12 patents were issued in Germany (DE), wherein most of them were published before 1990
- Similarly two patents were issued by EP while Japan (JP) held the last position with a single patent grant

6.1.8 *Grant analysis across leading assignees (excluding inventors)*

Graph 11: Grant analysis across leading assignees (excluding inventors)



Patent Dataset: 22 granted patents / utility models

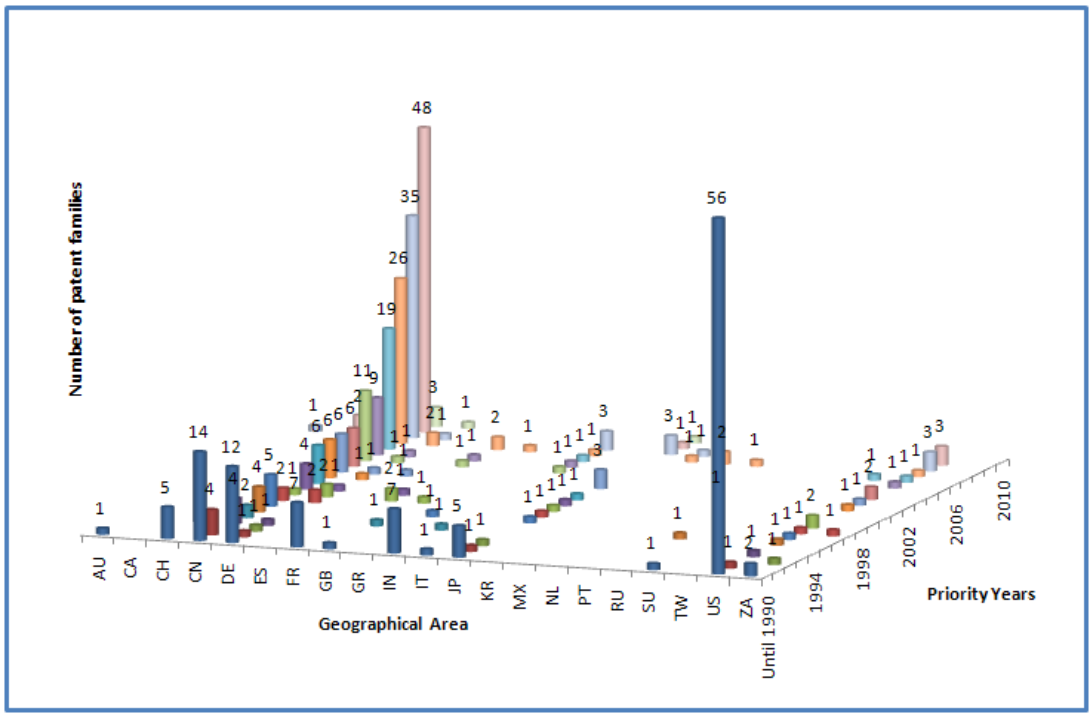
22 patents were granted / issued to top assignees across various patenting authorities like the US, the EP, JP, DE and CN in the field of complete solar cooking systems. AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY and CURTISS-WRIGHT CORP had two patents each, thereby emerging as the leaders. CURTISS-WRIGHT CORP got granted both its patents from the US, while the AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY got one patent each from the EP and JP.

OTMATO AG, KERNFORSCHUNGSZENTRUM KARLSRUHE GMBH and FRAUNHOFER-GESELLSCHAFT ZUR, each obtained a grant from the DE authority. From China, CHUNHUI SCIENCE AND TECHNOLOGY INDUSTRY CO LTD, BEIJING ENERGY-SAVING TECHNOLOGY SERVICE CENTRE and TIANHE LIGHT ENERGY CO LTD obtained one patent each.

Other assignees including SOLAR POWER SOLUTIONS INC, RKS DESIGN INC, INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE, SUN IT ENTERPRISES, THE SOLAR GOURMET CORP, AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY, BURNS MILWAUKEE INC, NITTO KOHKI CO LTD, SOLAR BAR B QUE CORP, THE RAYMOND LEE ORGANIZATION INC, SOLAR PRODUCTS CORP and CARMER IND INC hold a patent each from the US authority.

6.1.9 First-filing (priority) analysis by geographical area/patenting authority and priority year:

Graph 12: First-filing (priority) analysis by geographical area/patenting authority and priority year



Patent Dataset: 397 patent families

An analysis of the first filing across geographies relating to complete solar cooking systems showed that a maximum of 54% (215 patent inventions) of the 397 patent family members were first filed in China. The maximum filing activity was witnessed in the year 2009 with 48 patent inventions. This was followed by the immediately preceding years 2008 and 2007 with 35 and 26 patent inventions respectively. A key trend to be noted is that filing activity in China has been consistently increasing since 2004.

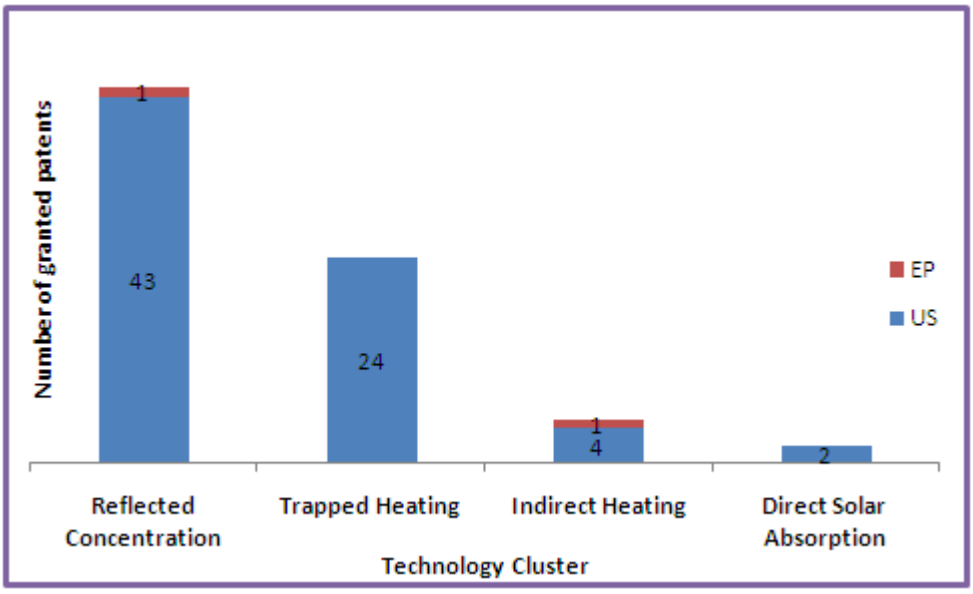
The US was the next leading patent issuing authority with a share of almost 19% (76 patent inventions) of the total patent family members. In contrast to the trend witnessed in the Chinese patent authority, a predominant number of US filings (56 patent inventions of the 76 patent inventions) occurred prior to the year 1990.

Other countries including Germany, India and France also played a significant role in the complete solar cooking systems with 28, 15 and 14 patent inventions respectively. Here again, the entire filing activity can be traced prior to 1990.

At the overall level, until 1990, the US was the prominent patent issuing authority with a maximum number of first filings (56 patent inventions). However, subsequent to the year 2004, China has become a prolific player in this technology space and has established a clear lead over the US.

6.1.10 Grant analysis (US and EP) across the technology clusters:

Graph 13: Grant analysis (US and EP) across the technology clusters

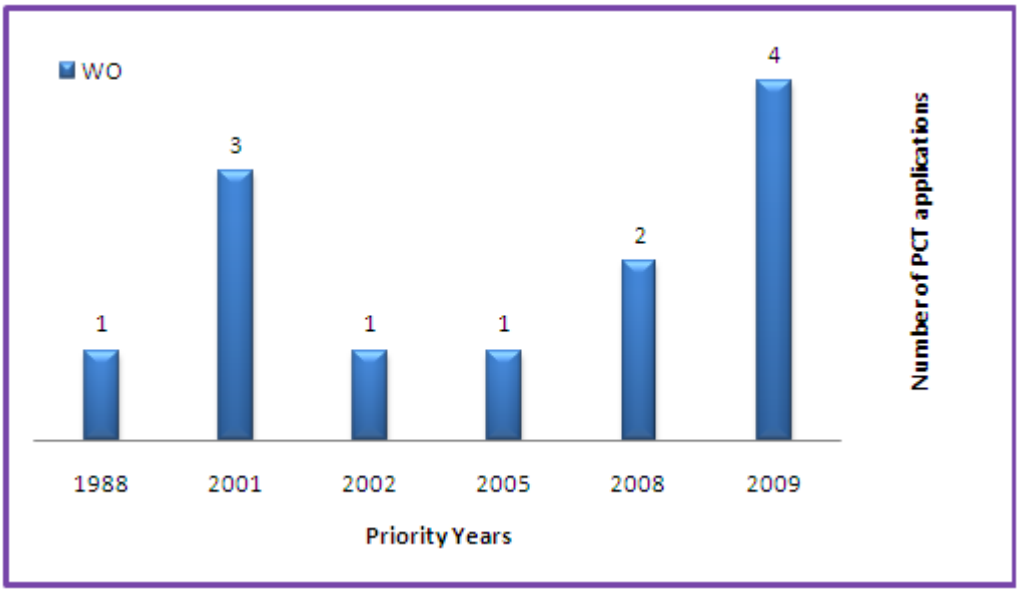


Patent Dataset: 75 granted patents / utility models

The USPTO emerged as the leader in terms of grants accounting for 73 patents in a total of 397, while the EPO only had 2 grants. Among 73 US patents, the reflected concentration method dominates the technology landscape with about 43 patents, while the trapped heating method follows next with 24 patents. In the case of the EPO, the reflected concentration method and indirect heating method were represented by one patent each.

6.1.11 PCT applications by priority year

Graph 14: PCT applications by priority year

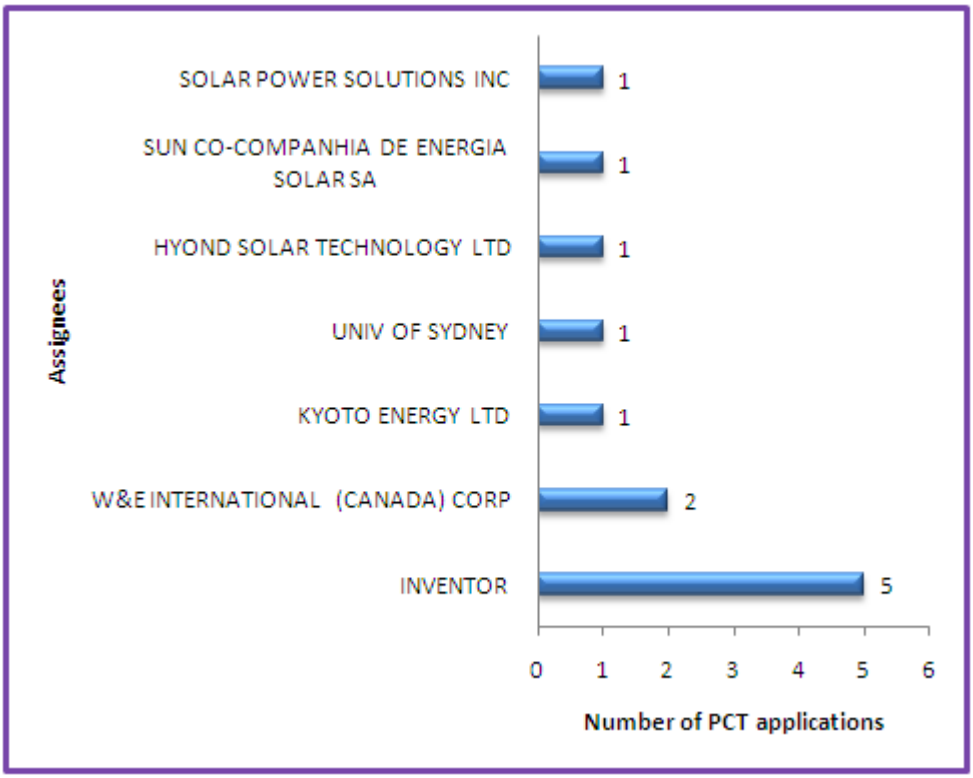


Patent Dataset: 12 PCT Applications

Surprisingly, the PCT route doesn't seem to find favor among industry participants with regards to complete solar cooking systems. Also, there appears to be a long gap in the filing activity over a time period. Subsequent to 1988, PCT activity was reflected only in the year 2001, while the year 2009 represented the highest filing activity period with four PCT filings. Other leading years include 2001 and 2008 with three and two filings respectively.

6.1.12 Breakdown of PCT applications by assignee

Graph 15: Breakdown of PCT applications by assignee

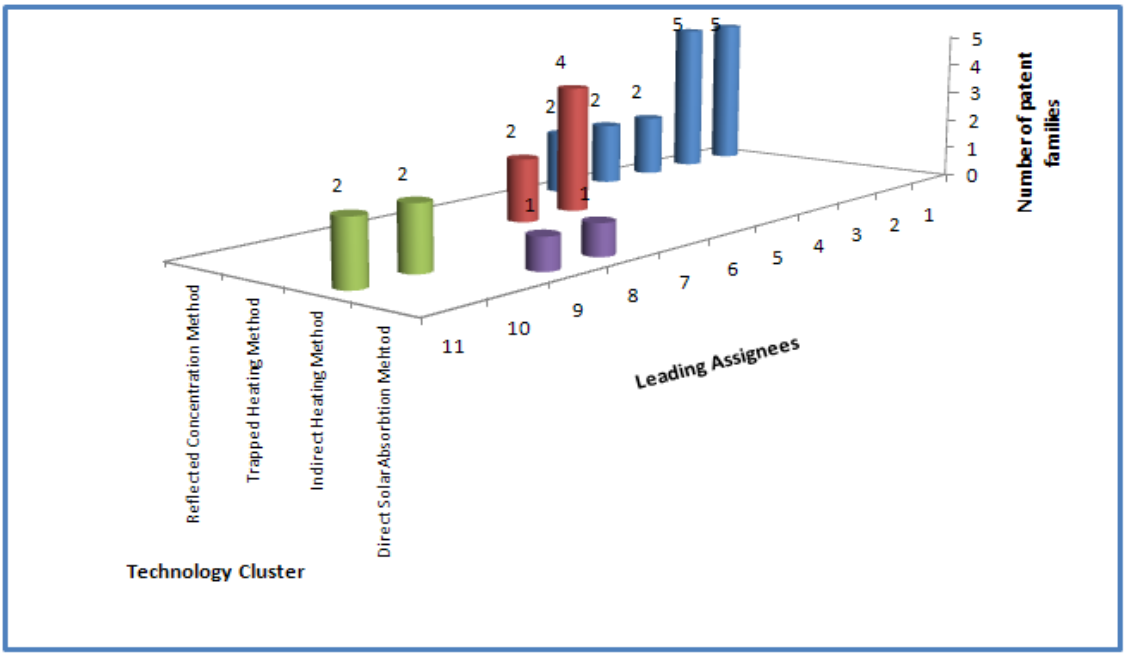


Patent Dataset: 12 PCT Applications

Individual inventors dominated the PCT route when compared to other assignee categories. In total, the individual inventor category accounted for five filings. W&E INTERNATIONAL (CANADA) CORP is the only assignee which holds two PCT applications in the complete solar cooking systems. Other assignees, including KYOTO ENERGY LTD, UNIVERSITY OF SYDNEY, HYOND SOLAR TECHNOLOGY LTD, SUN CO-COMPANHIA DE ENERGIA SOLAR SA and SOLAR POWER SOLUTIONS INC had a single PCT filling each.

6.1.13 Technology clusters across leading assignees:

Graph 16: Technology clusters across leading assignees



Patent Dataset: 397 patent families

1	Beijing hebaiyi ecology energy sources technology development co ltd
2	Beijing wisword hi tech co ltd
3	Agency of industrial science and technology
4	Beijing energy-saving technology service centre
5	Industrial technology research institute
6	Zhuhai double happiness electric appliance co ltd
7	Curtiss-wright corp
8	RKS design inc
9	Terada tekkosho kk
10	Univ of sydney
11	W&E international (canada) corp

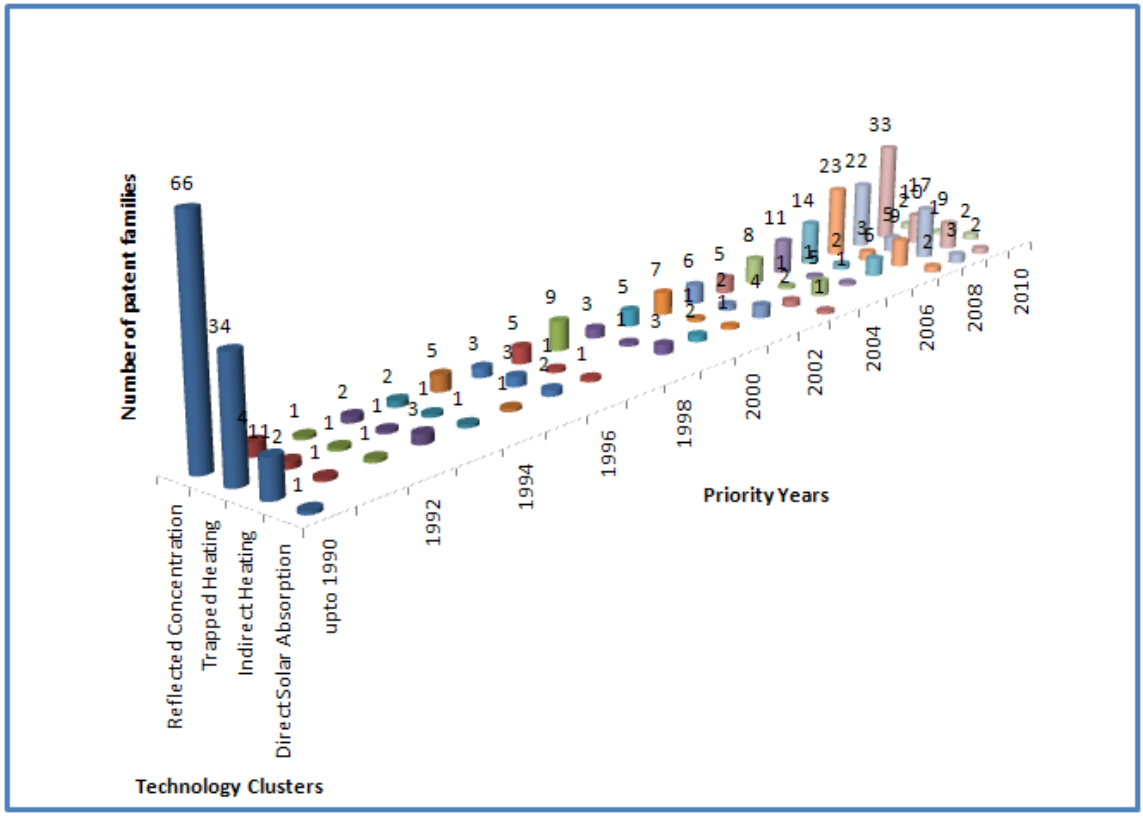
In the reflected concentration heating method, BEIJING WISWORD HI-TECH. CO. LTD and BEIJING BAIHEYI ECOLOGY ENERGY SOURCES led the portfolio with five patent family members each. They were followed by AGENCY OF INDUSTRIAL SCIENCE AND TECHNOLOGY, BEIJING ENERGY-SAVING TECHNOLOGY SERVICE CENTRE and INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE with two patent family members each.

ZHUHAI DOUBLE HAPPINESS ELECTRIC APPLIANCE CO LTD and CURTISS-WRIGHT CORP had four and two patent family members respectively in the trapped heating method. Direct solar absorption method accounted minimum number of patent family members. RKS DESIGN INC and TERADA TEKKOSHO KK shared this direct solar absorption portfolio with one patent family each

UNIVERSITY OF SYDNEY and W&E INTERNATIONAL (CANADA) CORP had two patent family members, each in the indirect heating method.

6.1.14 Technology clusters over priority year analysis:

Graph 17: Technology clusters over priority year analysis



Patent Dataset: 397 patent families

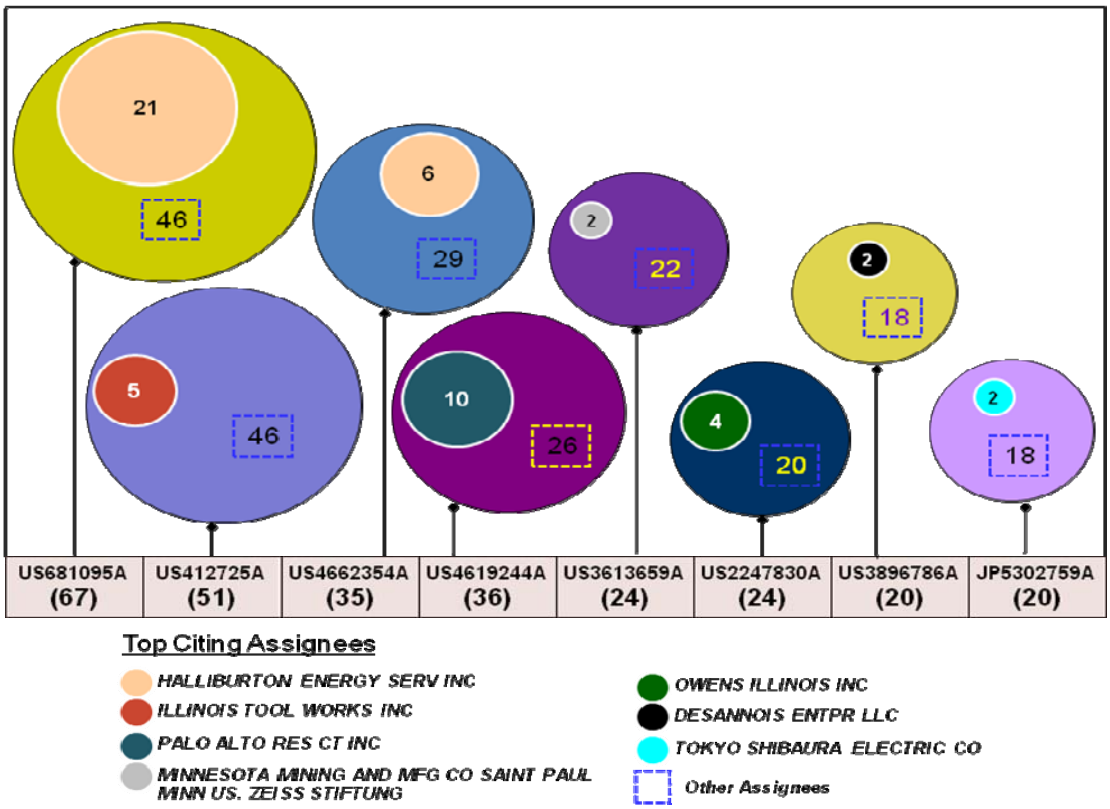
At the overall level, patenting activity in the solar cooking domain can be traced back to the 19th century. Since then, there was a gradual increase until 1990. During this period nearly 28% of all patenting activity was witnessed.

2005-2009 were clearly the defining years in terms of patenting activity in the complete solar cooking systems. During this period, nearly 35% of overall activity was focused on the indirect heating technology. This trend was particularly evident in the years 2008 and 2009 with 48 and 54 new filings respectively.

Comparing to other heating technologies, strong filing activity was witnessed in the reflected concentration method (over 60%). Trapped heating and indirect heating method have a share of 18% and 20% respectively.

6.1.15 Citation analysis:

Graph 18: Citation analysis



Patent Dataset: 13 patent families

A citation analysis of the top assignees was conducted based on the number of forward citations**** referred. The patent US681095A titled SOLAR OVEN AND COOKER that uses trapped heating technology and owned by SUNSHINE WATER HEATER CO had 67 forward citations wherein HALLIBURTON ENERGY SERV INC alone has cited the patent 21 times.

The other most cited patent is US4619244A titled SOLAR HEATER WITH CAVITY AND PHASE-CHANGE MATERIAL that uses reflected concentration, owned by an individual inventor; MARKS ALVIN M had 36 forward citations, where PALO ALTO RES CT INC alone has cited the patent 10 times. Moreover, the patent US4662354A with 14 family members referred by 35 citations in which HALLIBURTON ENERGY SERV INC cited for 6 times. Similarly, patent US412725A had 51 forward citations by various assignees, of which ILLINOIS TOOL WORKS INC alone cited the patent 5 times

Note: Reference - Annex II (Citation Analysis Table)

*Note: **** Patent document/scientific article/book that occur in a patent document, search report is a reference to the patent document, which may affect the patentability of the (claimed) invention. A "backward citation" is the term used for a traditional citation, i.e. the document that was published earlier, and which appears on the newer document's front page. In turn, the newer document is called the "forward citation" or "citing document."*

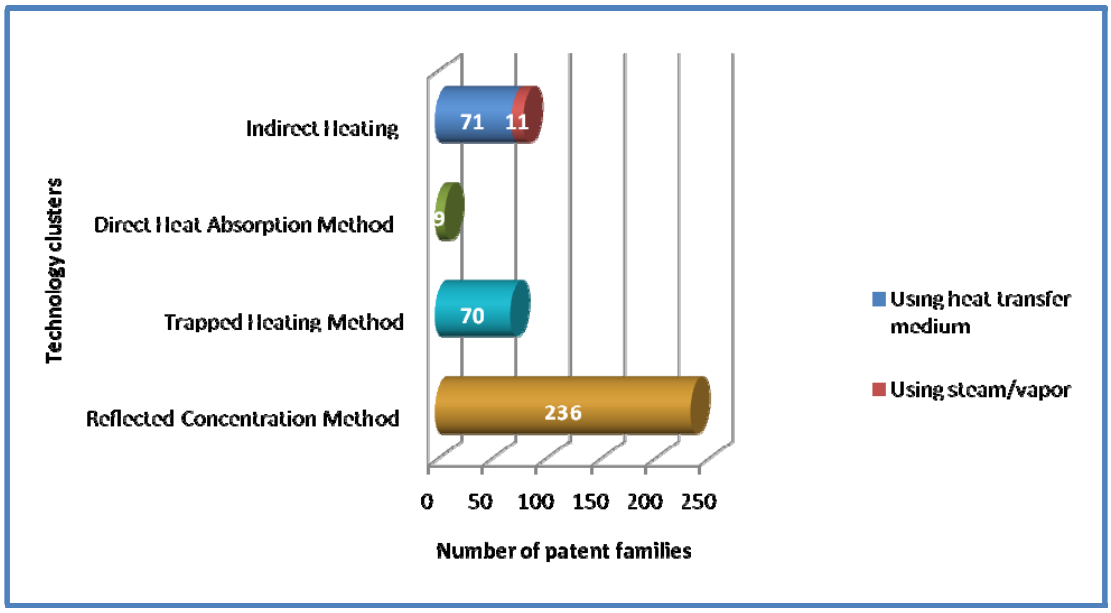
(http://www.wipo.int/pctdb/en/glossary.jsp#r)

6.2 Technical Overview

The 397 patent family members identified as relevant to the "Complete solar cooking systems/solutions" segment, were categorized based on the various heating techniques used. The four types of heating techniques include:

- Reflected concentration method
- Trapped heating method
- Indirect heating method
    - Using heat transfer medium
    - Using steam/vapor and
- Direct solar absorption method

Graph 19: Technical overview



Patent Dataset: 397 patent families

Table 5: Technology split

Reflected concentration method		236
Trapped heating method		70
Indirect heating method	Using heat transfer medium	71
	Using steam/vapor	11
Direct solar absorption method		9

An in-depth analysis of these heating technologies revealed that the "Reflected concentration method" is the predominant heating technique used in solar cooking. The heating technology accounts for 59% (or 236 patent family members) out of 397 patent family members. In the

reflected concentration heating method, solar energy is reflected and then concentrated towards the cooking surface. Due to its efficiency in terms of its ability to provide excellent light-gathering & easy sun tracking effects and of simple & easy construction, the “Reflected concentration method” is predominantly used in most of the solar cookers.

The 2nd most important technology is that of “Indirect heating methodology”, which is disclosed in 82 patent family members (accounting for 21% of the total 397 patent family members). A further analysis revealed that nearly 71 patent family members employed heat transfer medium for cooking, i.e. the heat is directed to the cooking surface via a heat transfer medium like water, oil, vacuum or air. Yet another 11 patent family members disclose steam / vapor cooking, i.e. the heat is transferred to the cooking surface through steam / vapor.

The other major heating techniques discussed include the “trapped heating method” which was disclosed in 70 patent family members (18% of 397 patent family members); and the “direct solar absorption method”, which was indicated in nine patent family members (2%).

The following section of the report discusses each of these heating techniques in detail.

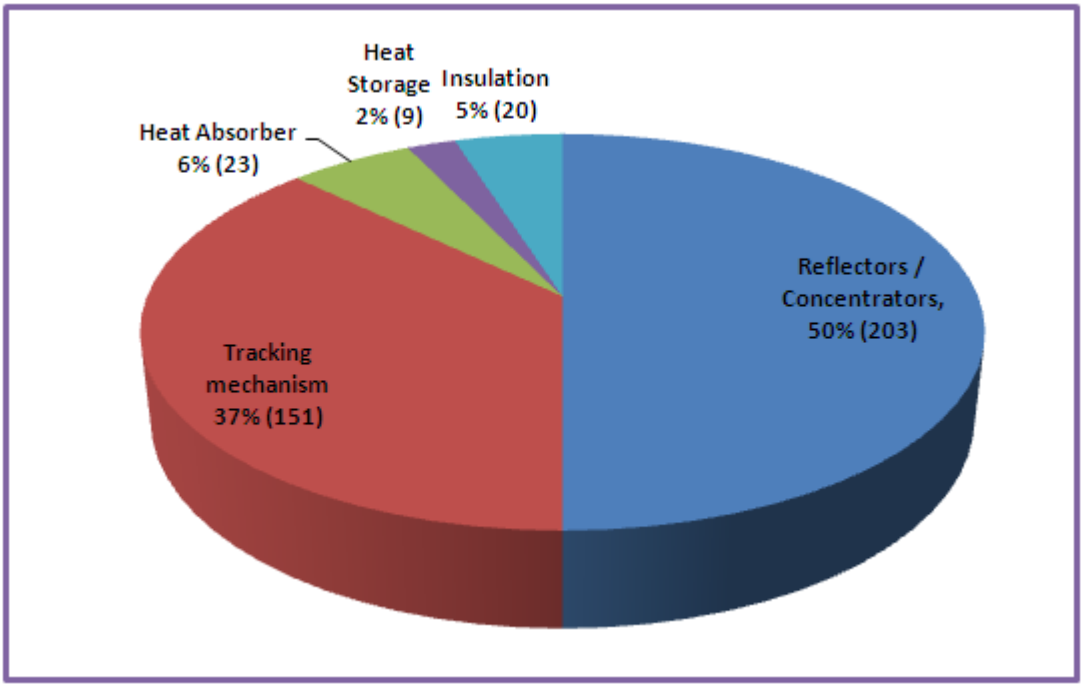
6.2.1 Reflected concentration method

In the reflected concentration method, reflectors are arranged in a way to concentrate and focus sunlight into the cooking surface/pot. The reflected concentration method produces heat according to the surface area of the reflecting material. Parabolic/concave reflectors are most commonly and predominantly used types in this method because of their large surface area and easy design construction. The cooking temperature can be varied by adjusting the reflector position. Optionally, solar/sun tracking devices can be fitted to this cooker to trace sunlight.

The search revealed that 236 patent family members out of the overall 397 patent family members pertaining to complete solar cooking systems disclosed the “Reflected concentration method” as the predominant heating technique for solar cooking.

The below chart exhibits the components spread in the reflected concentration technology.

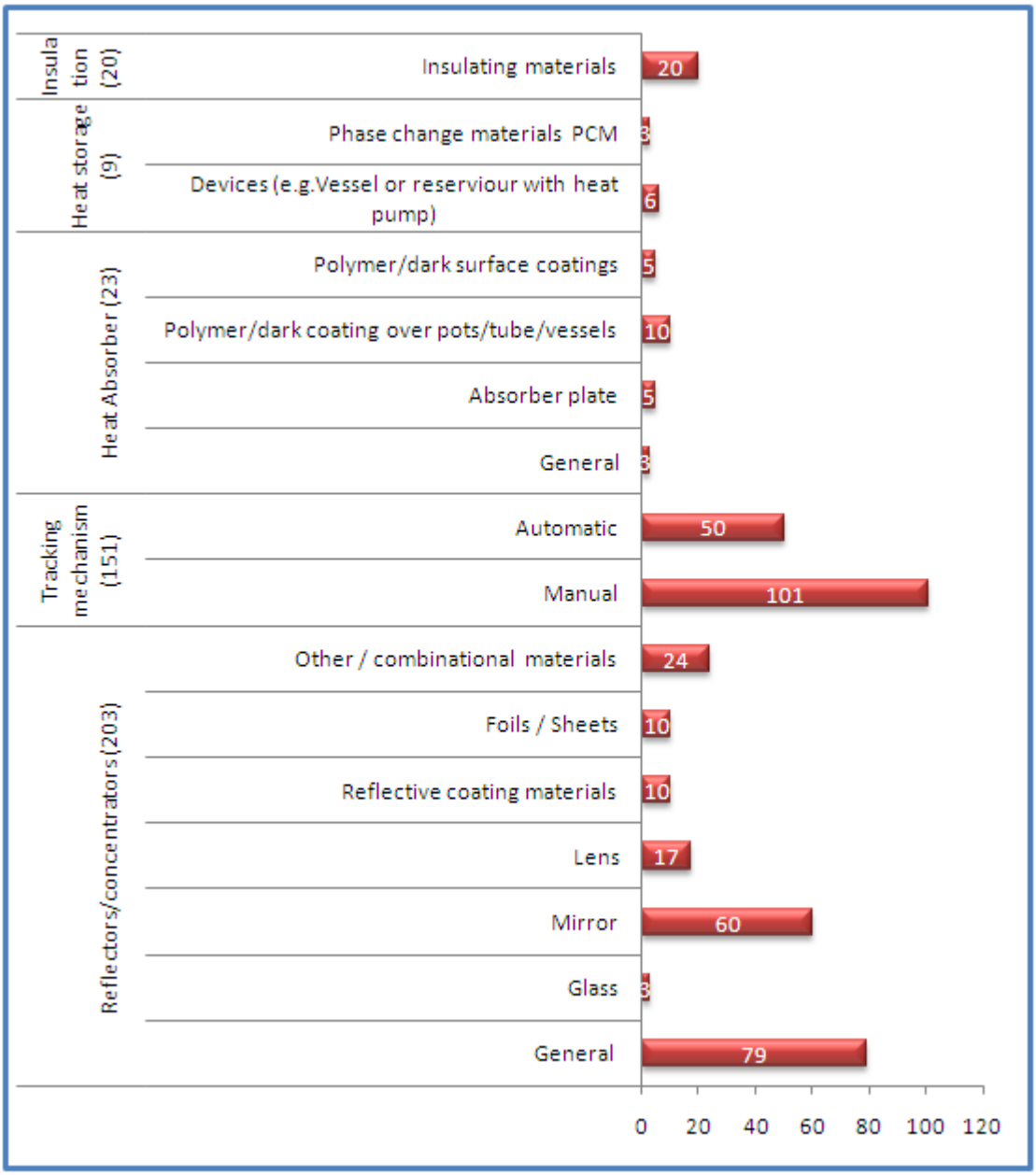
Graph 20: Share of various components in the reflected concentration technology



Patent Dataset: 236 patent families

The obtained 236 patent family members were further sub clustered on the basis of the type of materials and the type of objects used as part of reflectors/concentrators. The focus of this analysis was to identify various materials used for reflection/concentration, solar tracking mechanisms, types of heat absorbers, insulation and heat storage materials used. Among 236 patent family members reflector / concentrator and solar tracking devices dominated the entire portfolio.

Graph 21: Components split in the reflected concentration technology



Patent Dataset: 236 patent families

As indicated on the graph, 203 out of 236 patent family members refer to the type of reflecting/concentrating materials/mediums used in reflectors / concentrators which play a major role in cooking applications.

Within the reflectors/concentrators technology cluster, “mirrors” dominated with 60 patent family members for solar cooking application by reflecting the sun rays towards the surface / materials to be heated. Furthermore, this cluster had 17 patent family members with lens as a reflecting means for cooking applications. Reflective coating materials and Foils / Sheets were used as

reflective materials with an equal presence, namely ten patent family members in each sub cluster.

Similarly, Other / combinational materials such as Polypropylene fiber cement, thin steel plates, combination of steel plates & aluminized reflecting film, glass plates, aluminum or mercury coating, polyester resin glass fiber reinforced plastics etc. followed with 24 patent family members. Glass was discussed as a reflective/concentrating object in three patent family members. In addition, 79 patent family members disclosed various types of reflectors/collectors at a generic level without specifying the type of reflective materials/objects used.

In the total of 236 patent family members, 151 were further sub clustered under the “solar heat tracking” mechanism. Manual tracking mechanism had the highest representation with 101 patent family members. Sun tracking was carried out with the help of human intervention or by any other mechanical means such as using trolleys, transporting or moving wheels, support structures, etc. Yet further 50 patent family members discussed “automatic tracking mechanisms” with very effective automatic adjusting mechanisms i.e. sensor based or timing devices-based tracking, etc

Out of the 236 patent family members, 23 patent family members included heat absorption materials that increase the effectiveness of cooking. Dark coating over vessels and reflector surfaces’ shared the portfolio with ten and five patent family members respectively. Furthermore, five patent family members indicated the usage of absorber plates as the heat absorbing medium while three patent family members discussed the application of simple fibrous receiver to absorb rays.

The “Heat storage” sub-cluster had nine patent family members i.e. vessels or reservoirs with heat pump and phase change material (six and three patent family members respectively), while Insulators, the final sub-cluster, had about 20 patent family members.

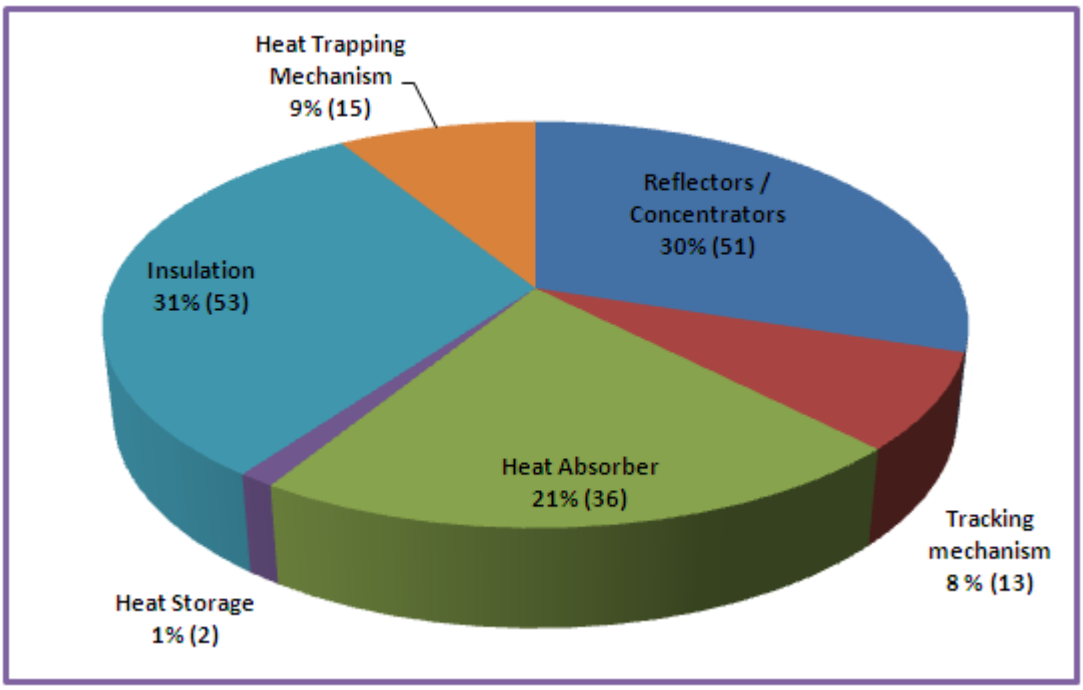
6.2.2 Trapped Heating Method

The search identified 70 patent family members which discuss the “trapped heating” method as the predominant heating technique.

In the trapped heating method, heat is trapped inside the box/chamber to heat the food or the cooking pan, which is placed inside the cooking chamber. Heat absorbers (for absorbing heat) and insulators (to retain the heat inside) are the more important components used in this technique. The heat absorber located inside the box/chamber, has a preferably black or a dark coating, which is used for maximum heat absorption.

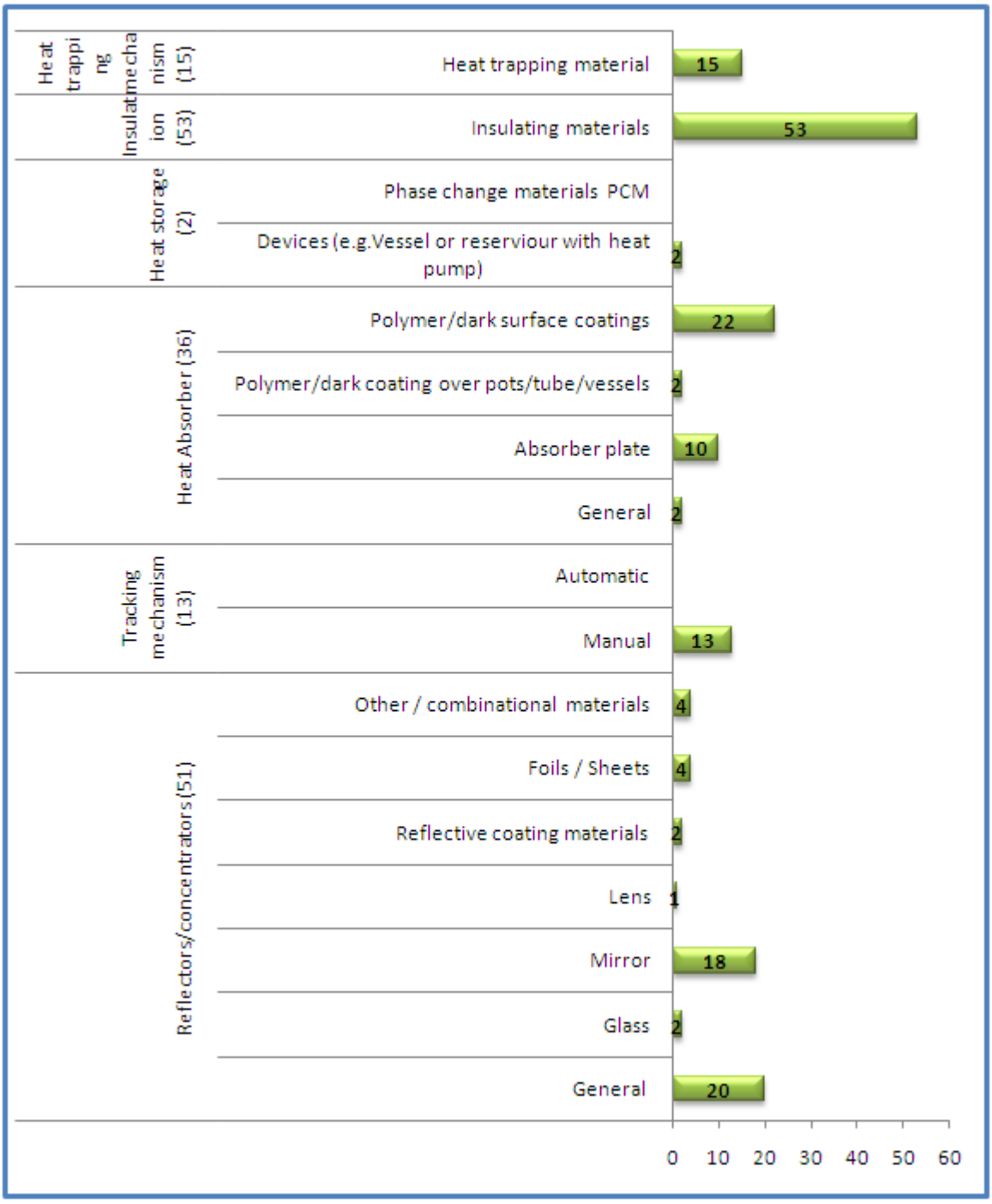
The box/chamber is surrounded by the insulating material that is used to reduce the heat loss. This technique does not get very high temperatures but it provides a medium temperature for longer duration. Additionally, the reflector arrangement can be placed above the box/chamber to direct the sunrays inside the cooking chamber/box. Most commonly, box type solar cookers use this trapped heating technique.

Graph 22: Components spread in the trapped heating method



Patent Dataset: 70 patent families

Graph 23: Components of the trapped heating method



Patent Dataset: 70 patent families

Accordingly, as part of the analysis, these 70 patent family members were clustered in terms of heat trapping elements, types of heat absorber materials used, materials used in reflectors and the availability of insulators / insulating materials.

Among the 70 patent family members focusing on trapped heating technology 15 discussed extensively about the various heat trap arrangements. The heat trap is a prominent component in this “trapped heating method”, because it helps the solar cooking system to retain the absorbed heat within the cooking box for a long time. The different heat trap arrangements & materials discussed include glazing materials, glass panels, etc.

13 patent family members also discussed about manual solar tracking by using various arrangements such as box type structures with the aid of human intervention etc. Further 42 patent family members described various heat absorber materials which increase the effectiveness of cooking. Dark coating over vessels and polymer/dark surface coatings shared the portfolio with eight and 22 patent family members respectively. In addition, ten patent family members discussed absorber plates as the heat absorbing material, while additionally two patent family members disclosed the presence of absorbing medium. Two patent family members disclosed the usage of heat storage devices (e.g. vessel or reservoir with heat pump).

51 patent family members further discussed different reflector/concentrator materials/objects across the following categories:

- Mirror (18 patent family members)
- Reflective coating materials and Foils/Sheets (Two & Four patent family members)
- Other / combinational materials (Four patent family members)
- Glass and lens (Two & One patent family members)
- General Type (20 patent family members)

53 patent family members further disclosed various insulating materials such as fiberglass, rigid urethane foam, silicon rubber etc.

6.2.3 Indirect Heating

The search revealed 82 patent family members predominantly discussed about the indirect method for using solar heat to cook food.

In case of the indirect type of heating food, solar heat is physically displaced from the collector and a heat transferring medium is used to convey the heat to the cooking pot. The main advantage of indirect solar heating technique is that heat can be collected outdoors and then brought indoors for cooking. The indirect heating of food can be carried out by the following techniques:

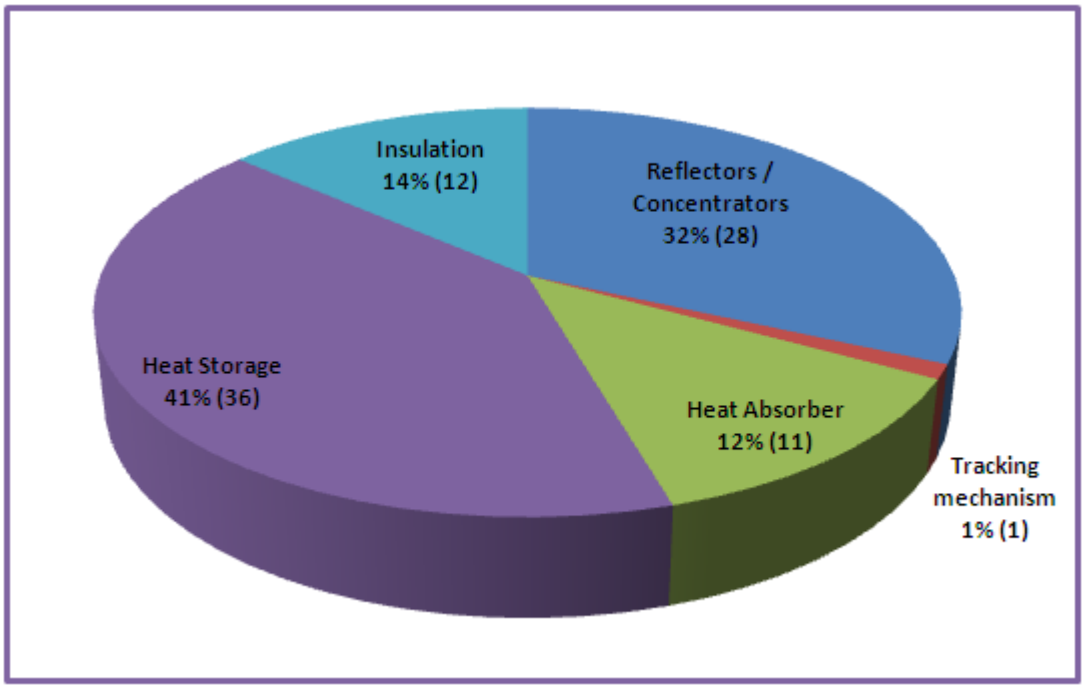
- Conversion of liquid into steam and then using the steam to cook the food; Water / liquid medium is heated and then converted into steam / vapor and subsequently the steam is directed to the cooking surface via a pipe or a conduit to cook the food
- Usage of heat transfer/conducting medium which conducts the solar heat and gets heated, which is then circulated to the food to be cooked.

In this type of indirect heating method, solar heat is collected and transferred to the cooking surface through heat transfer medium such as water (where hot water is used for cooking and it is not converted into steam / vapor), air/vacuum, oil etc. The heat conducting medium is stored in heat storing/accumulating chambers which are in connection with heat collecting devices and the cooking pan is in direct contact with the heat transfer medium.

The collected solar heat is conveyed through pipe arrangements into a heat accumulator/storage device, which comprises the heat transfer/conducting medium. The heat conducting medium gets heated and conducts the heat to the surface to be heated or to the cooking device.

Different types of heat conducting medium discussed in the patent documents include oil, water, sulphuric acid, nitrate etc. Few of the patent family members also disclosed the usage of optical fiber cables for transferring the light energy, which are then converted into heat energy towards the cooking area.

Graph 24: Components of indirect heating method technology

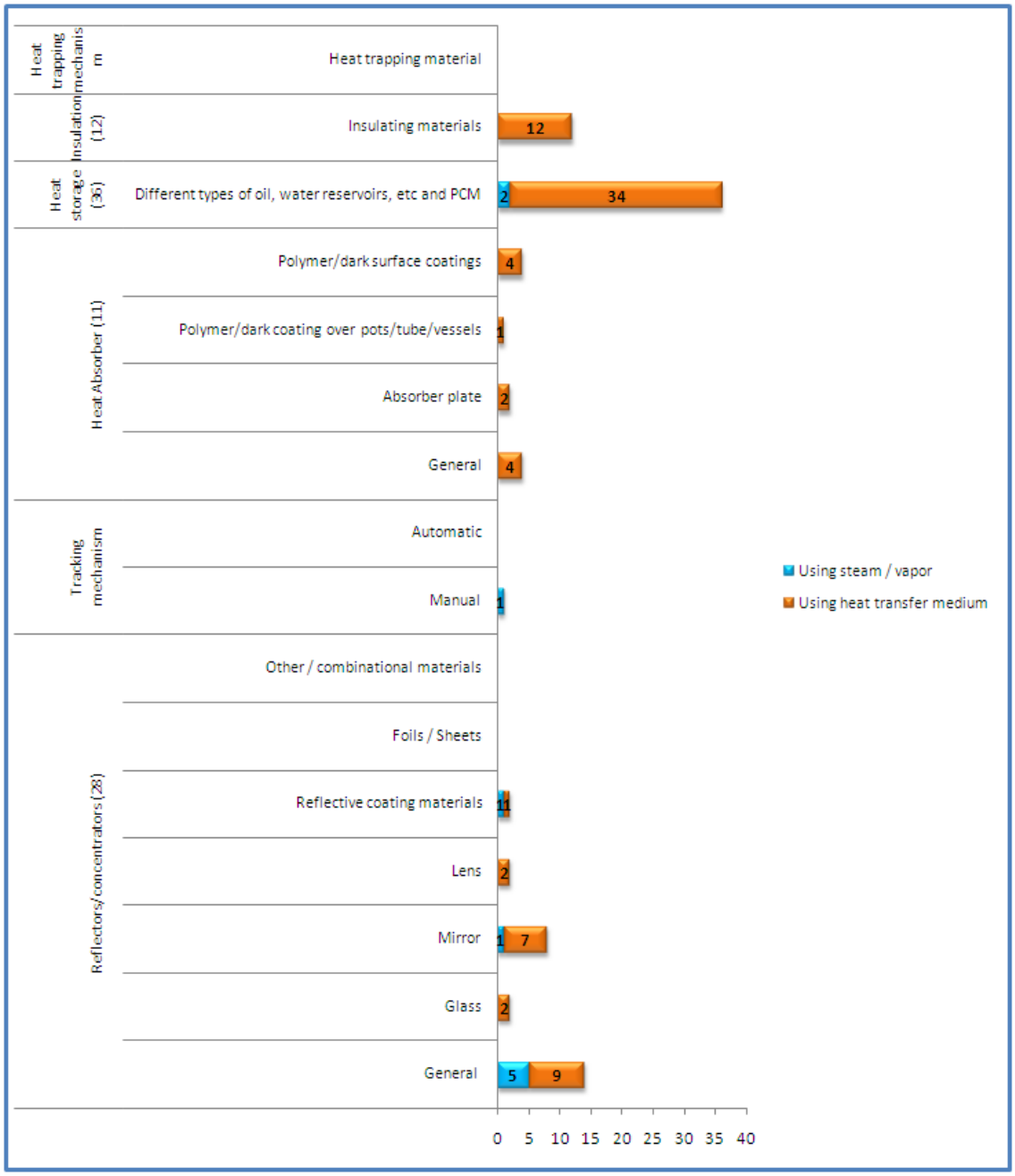


Patent Dataset: 82 patent families

The chart above exhibits the spread of components used in the indirect heating technique. Indirect heating technique is again classified into two categories (i) using steam / vapor (ii) using heat transfer medium.

Cooking by heat transfer medium is more commonly used when compared to steam / vapor cooking. Storage devices play an important role in this technique, as the heat is collected from outdoors and used for indoor cooking. Other components like reflector, insulator, tracking device and absorber are also used to enhance the efficiency of cooking.

Graph 25: Components of indirect heating method



Patent Dataset: 82 patent families

Among the 82 patent family members, 71 patent family members disclosed different types of heat transfer mediums used in indirect heating whereas 11 patent family members disclosed indirect solar heating utilizing steam/vapor.

Using steam / vapor

Only 11 patent family members disclosed indirect means of solar cooking which utilize steam/vapor to cook the food. Among these 11 patent family members, two patent family members further discuss the usage of heat/energy storing devices for storing heat, which is helpful to cook after sunset. One patent family in fact discussed a method for tracking solar light by manually rotating the concentrator.

Using heat transfer medium:

Cookers that use indirect heating are simple in construction, provide high energy storage for hours and are convenient to use.

71 patent family members discussed different types of heat storage devices and heat transfer/conducting mediums used to carry out indirect solar heating. 21 out of those described different reflective materials useful for enhancing solar cooking by reflecting more solar light. Among these 21 family members, seven disclosed the usage of mirror as a reflective surface, while two patent family members each discussed the usage of glass & lens as reflective medium, one other patent family discussed about reflective coating as a reflective surface. The remaining nine patent family members didn't detail any specific reflective materials/objects.

Solar cooking can be effectively carried out by proper sun tracking methods. Under this indirect heating category, only one patent family discloses methods for manual sun position tracking.

11 family members of the total results in this sub cluster focused on the heat absorber. Among these, there were four patent family members each under the "dark surface coatings" and "general heat absorbers". Two patent family members disclose the usage of heat absorber plates and one patent family discussed the usage of coating over the pot's surface to carry out efficient solar heat absorption.

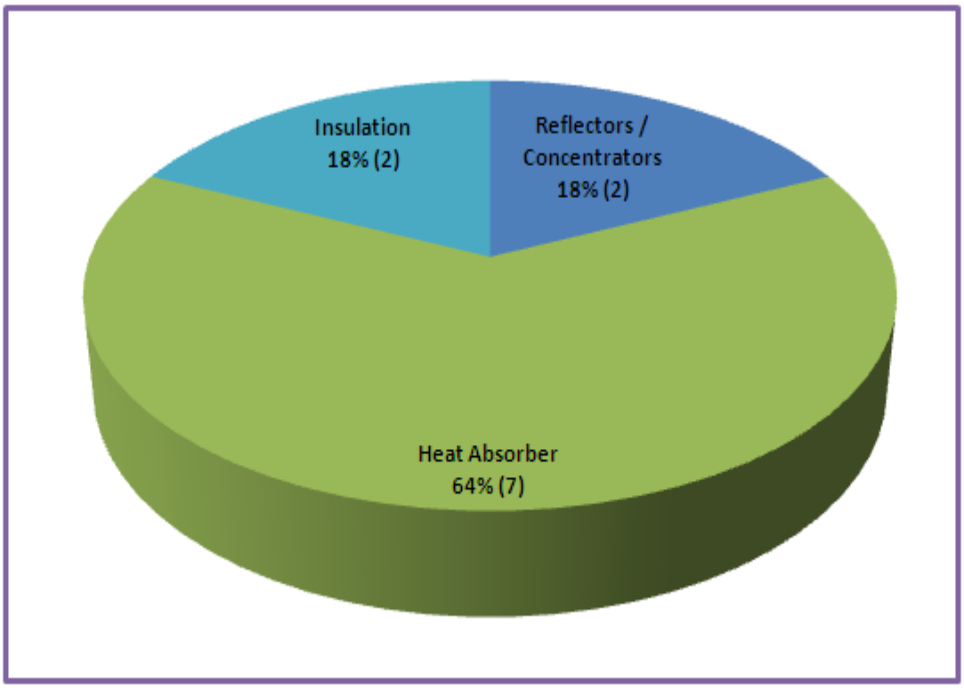
Heat storage devices played a predominant role in indirect heating. Among these 71 patent family members, 34 related to arrangement of different types of oil chambers, water reservoirs etc., i.e. an efficient means for storing large amount of heat for a long time. Furthermore, 12 patent family members discussed different types of insulators used for retaining the collected heat for a long time.

6.2.4 Direct Solar Absorption Method

This heating technique method involves placing the food into the absorber plate, which absorbs the heat for cooking or heating purposes.

An in-depth analysis of the patents indicated that only nine patent family members revealed this type of heating technique; wherein the food is kept directly in front of the sun rays for cooking or heating purposes. In this heating method cobblestone, absorbing plates and other heat absorbing materials are used to absorb heat and thus heat the oven. Moreover, glass or mirrors are employed for focusing sunlight on the absorbing materials.

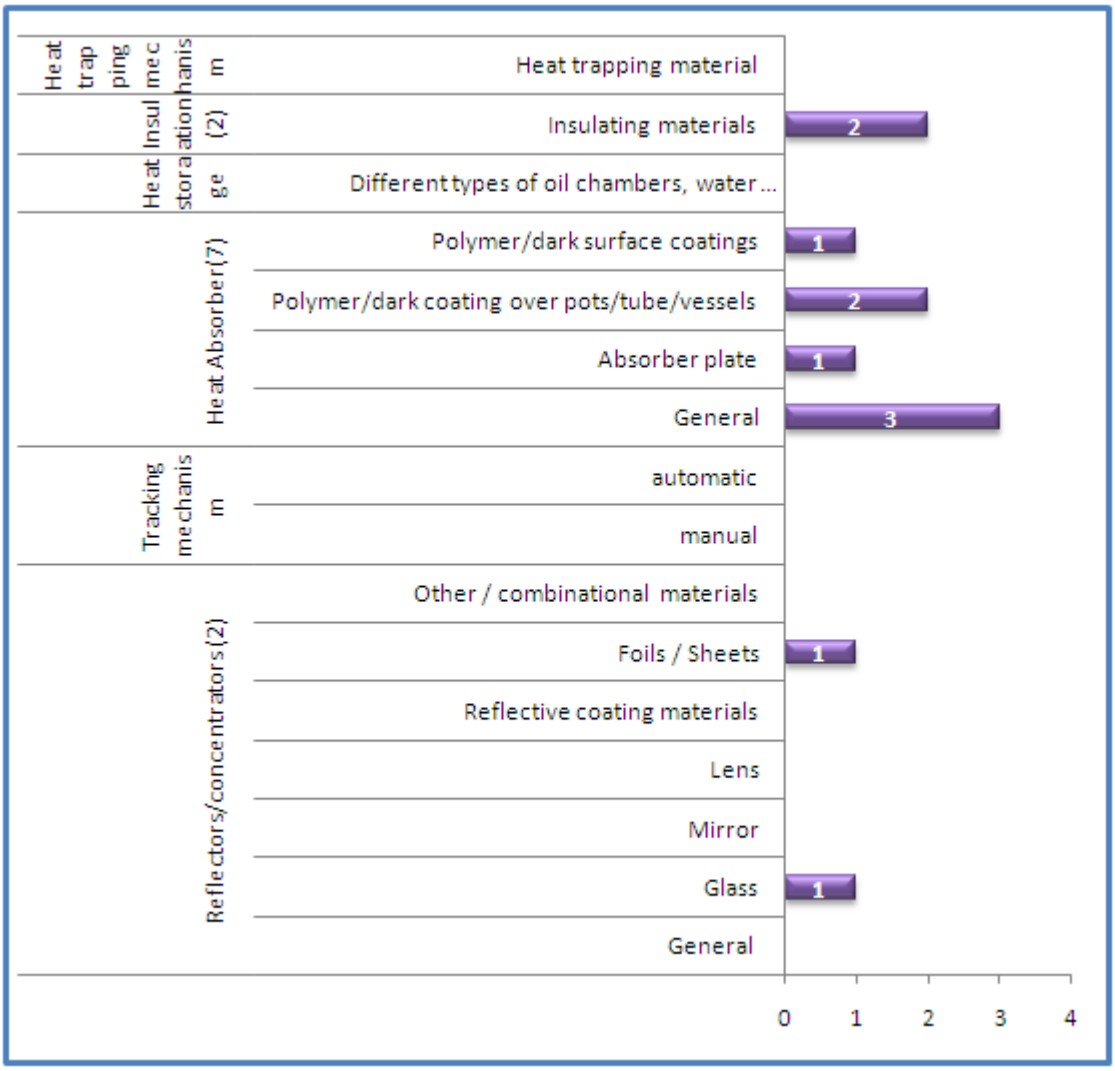
Graph 26: Components of direct solar absorption method



Patent Dataset: 9 patent families

The charts above and below exhibit the components spread across the direct absorption heating technique. In this technique the absorbing material is the important component which is used to directly absorb and retain the heat for some time which can be used for cooking.

Graph 27: Components split in direct solar absorption method



Patent Dataset: 9 patent families

Among these nine family members, only two family members disclosed the usage of glass and foils/sheets as a reflecting agent, while two other patent family members disclosed the use of insulation materials.

Two patent family members also disclosed polymer/dark coating over pots/tube/vessels and one family disclosed polymer/dark surface coatings.

In addition, one family disclosed the application of absorber plates as absorbing materials, while three family members disclosed the usage of absorbing materials at a broad level.

6.3 Product Identification

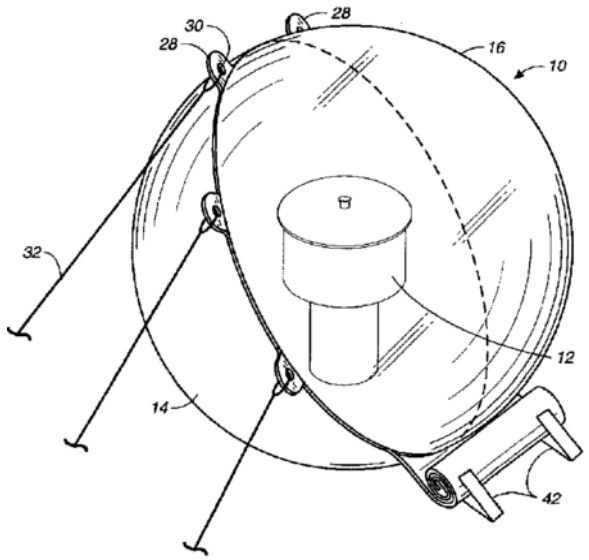
A comprehensive web search was conducted in the following online sources to identify whether the any of the obtained relevant patents were disclosed / indicated as the base patent in the product brochure or company website of any commercially available product.

- Google (http://www.google.com)
- Solar Cookers International (SCI) (http://solarcookers.org)
- Terra Foundation (http://www.terra.org/cocinas/directorioen.php)
- Solar Oven Society (http://www.solarovens.org)
- Solar Cooker-at-Cantinawest.com (http://www.solarcooker-at-cantinawest.com)
- Solar Household Energy, INC. (http://www.she-inc.org)
- Alibaba.com (http://www.alibaba.com)
- e-Bay.com (http://www.ebay.com)
- Amazon.com (http://www.amazon.com)
- Indiasolar.com (http://www.indiasolar.com)
- Solarcooking.wikia.com (http://solarcooking.wikia.com)
- Build it solar (http://www.builditsolar.com)
- Solaripedia (http://www.solaripedia.com)

In addition to the above websites, specific product search was done on leading assignees (Beijing WiSword Hi-tech Development Co. Ltd (http://wisword.en.ecplaza.net), Soltac (http://www.soltac.com) and Burns Milwaukee Inc (http://www.sunoven.com) etc.,) and leading inventors (Adnan Tarcici, Roger Bernard and Nix Martin etc.). The following 18 commercial products were identified from this search phase and have been listed along with their patent documents respectively.

Assignee / Inventor Name	STOUMEN; O'MALLEY O. (HEALDSBURG, CA), STOUMEN; JONATHAN A. (HEALDSBURG, CA)
Patent / Publication Number	US5893360A
Title	INFLATABLE SOLAR OVEN

Patent Image



Product Image

Product Name: CookSack ®

Reference Link	http://www.soltac.com/html/cooksackr.html
About Company / Product	The CookSack® is a patented solar device that is used to capture the heat energy of the Sun. Its parabolic mirror focuses sunlight on a thermally conductive pot filled with water to be used for purification, cooking or washing.

** Photo and text courtesy of Soltac*

Assignee / Inventor Name	SHI, YANG; (CN)
Patent / Publication Number	WO2010135909A1
Title	STEAM HEATING METHOD USING SOLAR ENERGY AND SOLAR STEAM COOKER

Patent Image

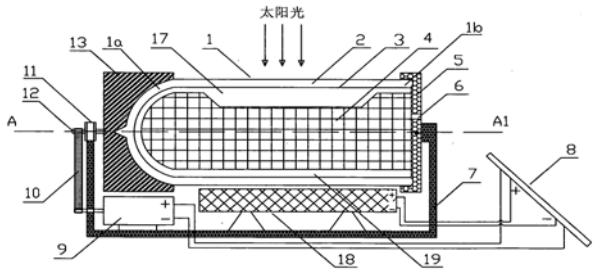
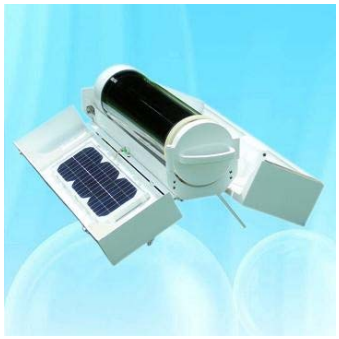


图 10

Product Image

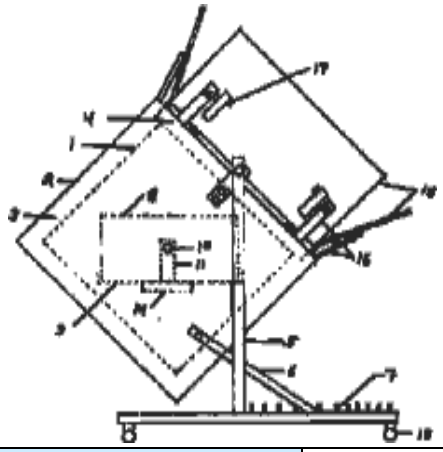


Reference Link	http://jiadeshun.gmc.globalmarket.com/products/details/portable-solar-cooker-104919.html http://jiadeshun.gmc.globalmarket.com/products/details/portable-solar-cooker-104920.html

** Photo and text courtesy of GlobalMarket Group*

Assignee / Inventor Name	SANKHA SUBHRA DATTA
Patent / Publication Number	639/KOL/2006A (DWPI Format : IN20060639I2)
Title	SUSPENDED BOX SOLAR OVEN

Patent Image



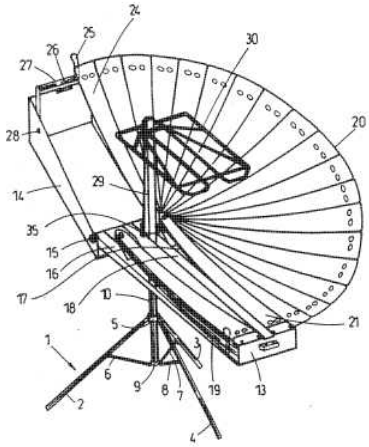
Product Image

Reference Link	http://www.solarcooking.org/datta-hanging-oven.pdf
About Company / Product	A suspended box solar oven with four number foldable mirror reflectors is presently designed and fabricated. It can be easily adjusted from 5 degree to 70 degree with respect to the ground by simply swing the suspended oven box and thereafter positioning of rectangular support frame in desired slot (14 such slot) formed by series of long studs, provided in inverted “T”-shaped main frame from which the oven box is suspended. The whole arrangement is clear from the photograph.

** Photo and text courtesy of Solar Cookers International*

Assignee / Inventor Name	DR. ADNAN TARCICI (TARCICI, ADNAN)
Patent / Publication Number	US5090399A
Title	SOLAR COOKER WITH A PARABOLIC REFLECTOR

Patent Image



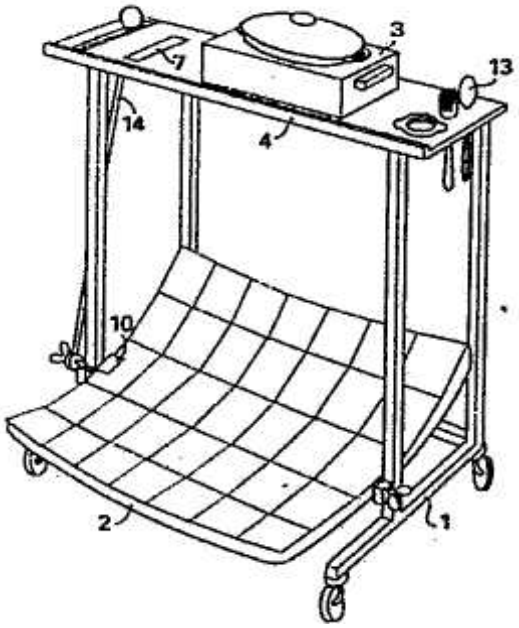
Product Image

Reference Link	http://www.moma.org/collection/browse_results.php?criteria=O%3ATA%3AE%3ACounterSpace&page_number=33&template_id=1&sort_order=1
About Company / Product	This solar cooker, which collapses completely into the portable box that also serves as its spine, was designed by professor and United Nations delegate Adnan Tarcici.

** Photo and text courtesy of Museum of Modern Art*

Assignee / Inventor Name	ROGER BERNARD (BERNARD ROGER)
Patent / Publication Number	FR2588644A1
Title	SOLAR COOKER HAVING IMPROVED CONVENIENCE

Patent Image



Product Image

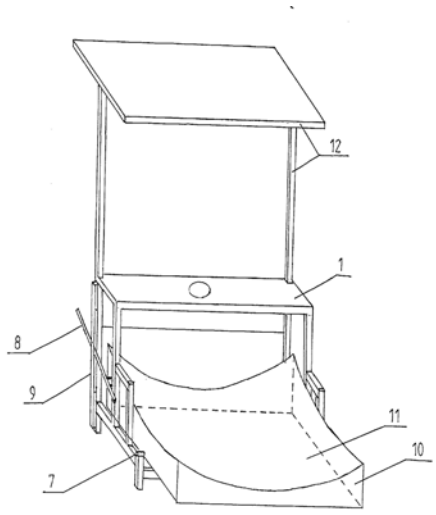
Product Name: Primrose

Reference Link	http://solarcooking.wikia.com/wiki/Primrose http://www.terra.org/cocinas/fichaen.php?id=23
About Company / Product	The Primrose, originally invented by Roger Bernard. It is constructed to serve as a little kitchen with the advantages to stay in the shade and stir the food during the cooking process. The cooking unit Primrose resists wind and, with minor modifications, all other weather conditions. The reflector can be put up for easy storage. Once ordered, a richly illustrated multilingual manual comes with the kit.

** Photo and text courtesy of Terra Foundation*

Assignee / Inventor Name	DEVOS XAVIER (FR)
Patent / Publication Number	FR2870587A1
Title	SOLAR COOKING DEVICE FOR E.G. HEATING FOOD, HAS TABLE INCLUDING TRAP SLIDING IN HORIZONTAL SLOT FOR BLOCKING RECESS, PARABOLOIDAL CONCENTRATOR ROTATING BY UTILIZING AXLE, AND LEVER SLIDING IN VERTICAL SLOT TO ADJUST CONCENTRATOR POSITION

Patent Image



Product Image

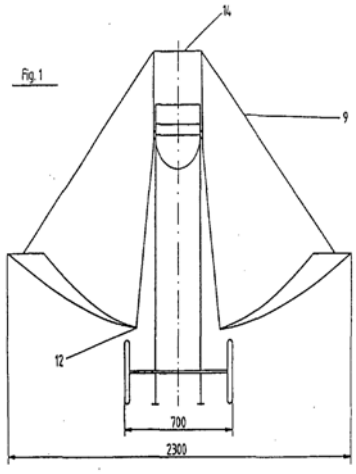
Product Name: Devos Cooker

Reference Link	http://tablesol.free.fr/Accueil%20EN/devos_cooker/devos_cooker.html http://www.terra.org/cocinas/fichaen.php?id=57
About Company / Product	The cooker is made of two main parts: 1- A concentrator, covered with mirrors, allows to focus solar rays under the pot. 2- A table made of wood or steel. In the middle, there is a hole, above which we put the pot. The table protects the cook from burns and dazzles. Other devices: To track the variation of solar altitude, the concentrator turns round a spindle, thanks to a lever. The heat in the focus point can be regulated thanks to a shutter, which we can slide more or less. (like a thermostat).

** Photo and text courtesy of Terra Foundation*

Assignee / Inventor Name	DESSEL JOCHEN
Patent / Publication Number	DE29808939U1
Title	SOLARKOCHER

Patent Image



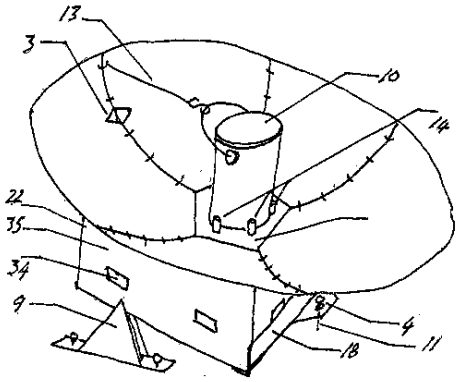
Product Image

Reference Link	http://www.terra.org/cocinas/fichaen.php?id=32 http://www.solar-papillon.com/
About Company / Product	Folding solar cooker with two sections of parabola which concentrate the solar radiation in the bottom of the cooking recipient. It uses direct solar radiation and it can be orientated with two movements: turning completely from the base, or moving the reflectors. The recipient support is fixed and it's possible to cook standing up from the upper part, which also reduces the risks of reflections and eye damage. Due to its design, there are not reflectors under the boiling area, this way there is no problem when spilling out some food.

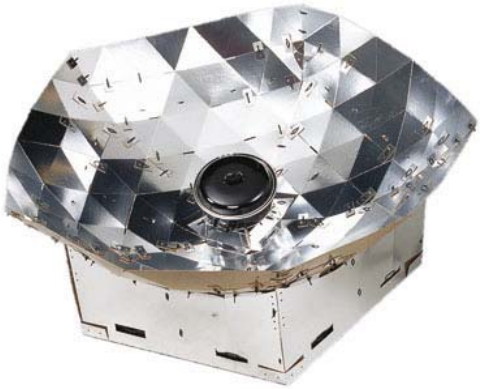
** Photo and text courtesy of Terra Foundation*

Assignee / Inventor Name	MICHAELIS DOMINIC [GB]; SOMERS MARIA [GB]
Patent / Publication Number	GB2341675A
Title	SOLAR COLLECTOR AND COOKER

Patent Image



Product Image



Reference Link	http://fr.solarcooking.wikia.com/wiki/Dominic_Michaelis
About Company / Product	Dominic Michaelis is the inventor, manufacturer and seller of Prometheus solar cooker.

** Photo and text courtesy of Solar Cookers World Network*

Assignee / Inventor Name	GEORGE OSCAR GAGE LOEF
Patent / Publication Number	GB801751A
Title	SOLAR COOKER

Patent Image

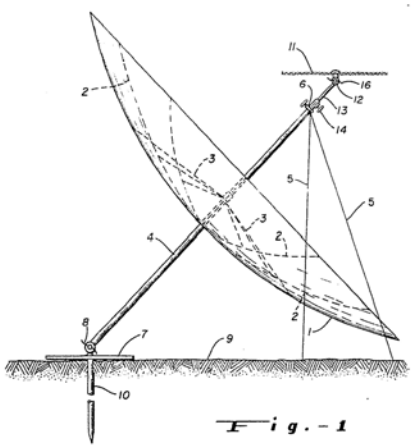


Fig. 1

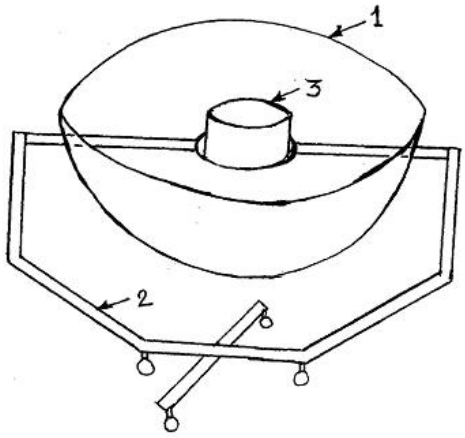
Product Image

Reference Link	http://solarcooking.wikia.com/wiki/George_Lof http://en.wikipedia.org/wiki/George_Lof#cite_note-wsj-6
About Company / Product	Löf invented a solar cooker, marketed as the Umbroiler, but it was not a commercial success.

** Photo and text courtesy of Solar Cookers World Network*

Assignee / Inventor Name	CHANDAK AJAY GIRDHARILAL
Patent / Publication Number	537/MUM/2005A (DWPI Format : IN20050537I3)
Title	CONCENTRATING SOLAR COOKER FOR BALCONY

Patent Image



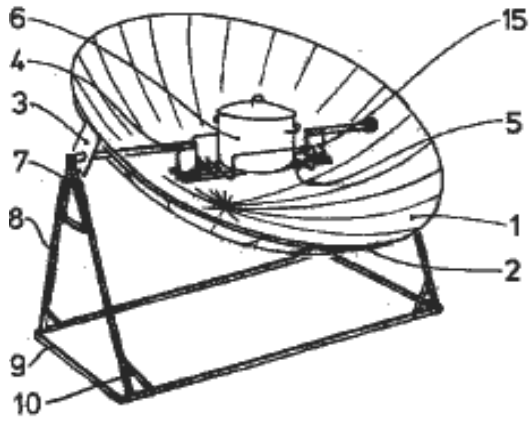
Product Image

Reference Link	http://www.princeindia.org/Balcony%20cooker%20article.pdf
About Company / Product	This innovative design of balcony solar cooker can bring about revolutionary changes in adoption of solar cooking by masses, especially by city dwellers. Field tests of last eight months are satisfactory and the product is being commercialised. The technology will be made available to interested entrepreneurs on mutually acceptable terms. Cost and performance of the innovative balcony cooker comparable to that of SK-14.

** Photo and text courtesy of PRINCE (Promoters and Researchers In Non - Conventional Energy)*

Assignee / Inventor Name	CLIMATE INTERCHANGE AG (CLIM) / Seifert Dieter
Patent / Publication Number	DE102007056456A1
Title	SOLAR COOKER HAS REFLECTOR FOR CONCENTRATION OF SOLAR RADIATION ON POT AND POT HOLDER, WHERE CENTRE PART OF POT HOLDER HAS TWO PARTIAL AXES FASTENED AT CENTRE PART AND TWO SUPPORTS ARRANGED LATERALLY AT REFLECTOR

Patent Image



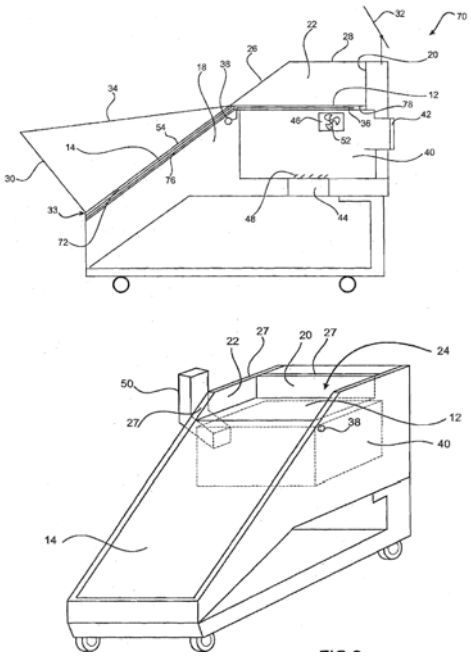
Product Image

Reference Link	http://www.techmonitor.net/tm/images/9/96/09may_jun_sf3.pdf http://solarcooking.wikia.com/wiki/Dieter_Seifert http://www.terra.org/cocinas/fichaen.php?id=92
About Company / Product	Commercial parabolic solar cooker. The high reflection aluminium sheets (Solar Surface) allow for high temperatures in the focus so the device performs almost like a conventional electric or gas cooker. The cooking rack is fixed to the base of the cooker and stays horizontal and flat while the parabolic reflector can be turned around to face it towards the sun. The cookers are sold in a box that contains the different pieces and tools needed for the assembling. The cooker alSol 1.4. can be assembled by 2 people in approximately 2 hours.

** Photo and text courtesy of Terra Foundation*

Assignee / Inventor Name	BOURKE NOEL
Patent / Publication Number	US20100139648A1
Title	COOKING DEVICE

Patent Image



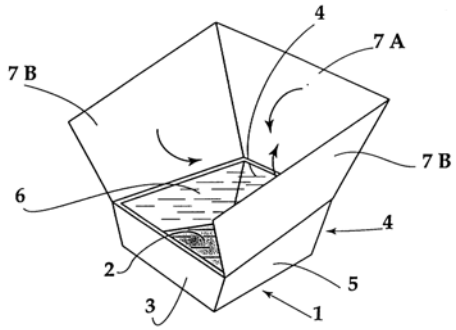
Product Image

Reference Link	http://solarcooking.wikia.com/wiki/Noel_Bourke
About Company / Product	This cooking device incorporates both box cooker and the panel cooker designs into one arrangement.

** Photo and text courtesy of Solar Cookers World Network*

Assignee / Inventor Name	BEALL JOAN
Patent / Publication Number	FR2801097A1
Title	SOLAR POWERED COOKING CONTAINER HAS BOX WITH HEAT REFLECTIVE SIDE-WALLS AND UPPER GLAZING PANEL

Patent Image



Product Image

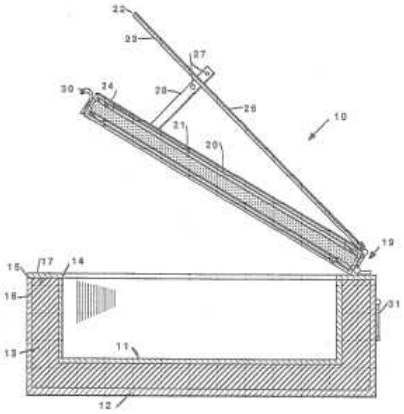
Product name: REM5

Reference Link	http://www.terra.org/cocinas/fichaen.php?id=17 http://www.synopsis.org/index1024/eng/indexeng.html
About Company / Product	SYNOPSIS, a research group with several projects about solar boiling at world scale. REM5 is a solar cooker box with a cover of single pane glass, aluminium frame and a policarbonate box, with three exterior reflectors. This model has been developed to be used and fabricated during cooperation projects in developing countries

** Photo and text courtesy of Terra Foundation*

Assignee / Inventor Name	GHATAK, RANEN N (president of United Solar Energy, Inc)
Patent / Publication Number	US4850339A
Title	SOLAR OVEN

Patent Image



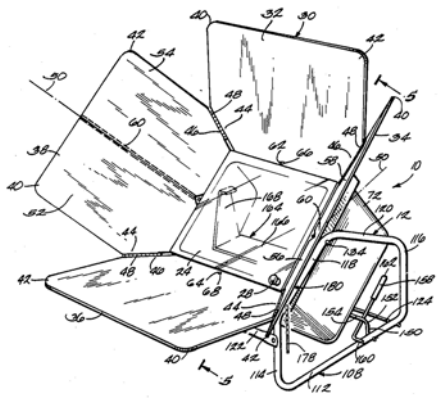
Product Image

	http://www.unitedsolarenergy.com/products/solar_oven.shtml
About Company / Product	The company's products range from a patented portable solar oven, which cooks food without the sooty mess of charcoal or costly propane, to a solar heating tank encased in what seems to be a skylight for installation on roofs.

** Photo and text courtesy of United Solar Energy, Inc.*

Assignee / Inventor Name	BURNS MILWAUKEE INC
Patent / Publication Number	US4848320A
Title	SOLAR OVEN

Patent Image



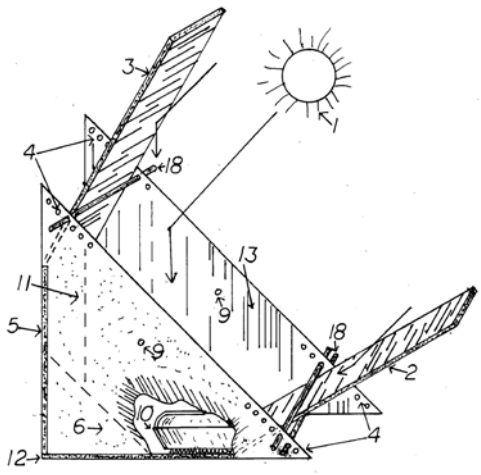
Product Image

Reference Link	http://www.solarcooker-at-cantinawest.com/global-sun-oven.html
About Company / Product	From 1986 to 1997 SUN OVENS® were made and marketed by Burns Milwaukee, Inc. Innovative features of the cooker are One piece collapsible reflectors Spill-proof elevator Easy temperature monitoring Self-contained leveling leg Extremely well insulated Light weight, easy to carry

** Photo and text courtesy of .solarcooker-at-cantinawest*

Assignee / Inventor Name	NIX MARTIN E
Patent / Publication Number	US20100071686A1
Title	WEDGE SHAPE SOLAR COOKER

Patent Image



Product Image

Reference Link	http://solarcooking.wikia.com/wiki/Martin_Nix http://solarcooking.wikia.com/wiki/Wedge_Solar_Cooker
About Company / Product	Martin Nix has been involved with various aspects of solar energy for number years. He is the designer of the Wedge Solar Cooker.

** Photo and text courtesy of Solar Cookers World Network*

Assignee / Inventor Name	RICHARD C WAREHAM
Patent / Publication Number	ZA9308400A
Title	A SOLAR COOKING APPARATUS

Patent Image	**Product Image**
No Image was found	 Product Name : SunStove

Reference Link	http://solarcooking.wikia.com/wiki/Richard_Wareham http://solarcooking.wikia.com/wiki/SunStove
About Company / Product	The Sunstove is the result of many hours of drawing, dozens of trial models and eventual capital input from **Richard C. Wareham**. This is a light solar oven, easy to move and store, with a cooking capacity of 5 to 6 litres of food, enough to feed a whole family

** Photo and text courtesy of Solar Cookers World Network*

Assignee / Inventor Name	RICHARD JAMES POCOCK
Patent / Publication Number	ZA9702924A
Title	SOLAR-POWERED COOKING APPARATUS

Patent Image	**Product Image**
No Image was found	 Product Name: Sun Catcher

Reference Link	http://solarcooking.wikia.com/wiki/Suncatcher
About Company / Product	The Suncatcher is a light-weight, fold-up solar cooker manufactured by **Richard Pocock** in South Africa. Suncatcher is an inexpensive and user friendly solar concentrator. It is great for warming up meals while hiking, boiling water while fishing.

** Photo and text courtesy of Solar Cookers World Network*

7.0 Segment II – Components only/also for solar cooking applications

Summary

Table 6: Summary on components only/also for solar cooking applications

Major Segment	Segment II
Segment title	**Components only/also for solar cooking applications**
Total number of patent family members (inventions)	**176**
Primary & sub clusters	**Concentrator/Reflector** • General • Glass • Mirror • Lens • Reflective coating materials • Foils / Sheets • Other / combinational materials **Collector** • General • Glass • Lens **Solar Tracking Device** • Automatic • Manual **Heat Absorber** • Absorber plate • Polymer/dark coating over pots / tubes / vessels **Other Accessories**

Cluster Definitions:

Table 7: Definitions

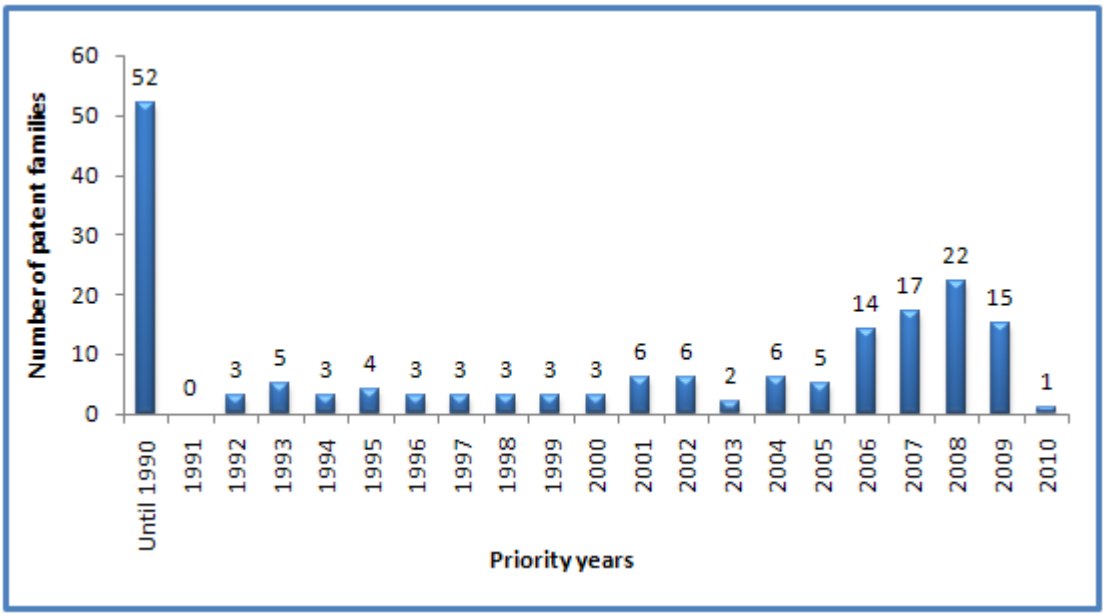
Cluster	Definition
Concentrator/Reflector	
Solar concentrators / reflectors direct solar energy onto the absorber area for producing sufficient heat energy for cooking. Reflectors directly reflect the gathered solar radiation over the absorber area whereas concentrators gather radiation over a large area and focus it onto a small absorber area.	
General	Concentrator / reflector arrangements/ reflective surfaces used to concentrate solar radiation to a focal point to be heated, whereas the type of reflective material used is not clearly specified
Glass	Concentration of light is achieved with the help of glass.
Mirror	Concentration of light is achieved using mirrors (reflection)
Lens	Concentration of light is achieved using transparent lens (refraction)
Reflective coating materials	Different reflecting materials coated on the surface of the materials such as cardboard, glass surfaces useful for reflecting/concentrating solar radiation.
Foils / Sheets	Concentration of light is achieved by using aluminium foil, silver foil, etc.,
Other materials	Concentration of light is achieved with the help of other materials that are not specified above or with the combination of above said materials
Collector	
Solar Collectors are designed to collect heat by absorbing sunlight and the collected heat is then efficiently used for cooking.	
General	Solar heat collecting devices/surfaces used to collect solar radiation , whereas the type of material/surface used to collect the heat is not clearly specified
Glass	Solar heat collection is achieved with the help of glass.
Lens	Solar heat collection is achieved using convex lens.
Solar Tracking Device	
Devices/arrangements of solar cooker which are used to track/follow the sun throughout the day regardless of its location or angle and to align with the cooker to focus the solar radiations accurately.	
Automatic	Automatic or electronically controlled tracking / turning mechanism that allows rotation of the reflector or cooking assembly either vertical or horizontal direction to focus the sunlight
Manual	The reflector position is controlled manually. This can be done using any mechanical means like using drive shaft or by means of manual tilting / rotation.
Heat Absorber	
Materials/components used to absorb the direct or reflected solar radiations and to convert them into longer wavelength heat energy and to radiate it from the interior materials.	

Cluster	Definition
Absorber plate	In plate-type absorbers, two sheets are sandwiched together for allowing heat transfer fluid between the passages formed in the plates. The absorber is generally made of copper or aluminum.
Polymer/dark coating over pots/tubes/vessels	Black or dark surface coatings coated over the cooking pots/vessels for absorbing heat.
Other Accessories	
Other accessories like stands for supporting and adjusting a solar ovens position or direction with respect to the sun, vessels / pots / other cooking apparatus only/also used in solar cooking applications	

7.1 Significant trends in Components only/also for solar cooking applications

7.1.1. Patenting Activity over Priority years:

Graph 28: Patenting activity over priority years



Patent Dataset: 176 patent families

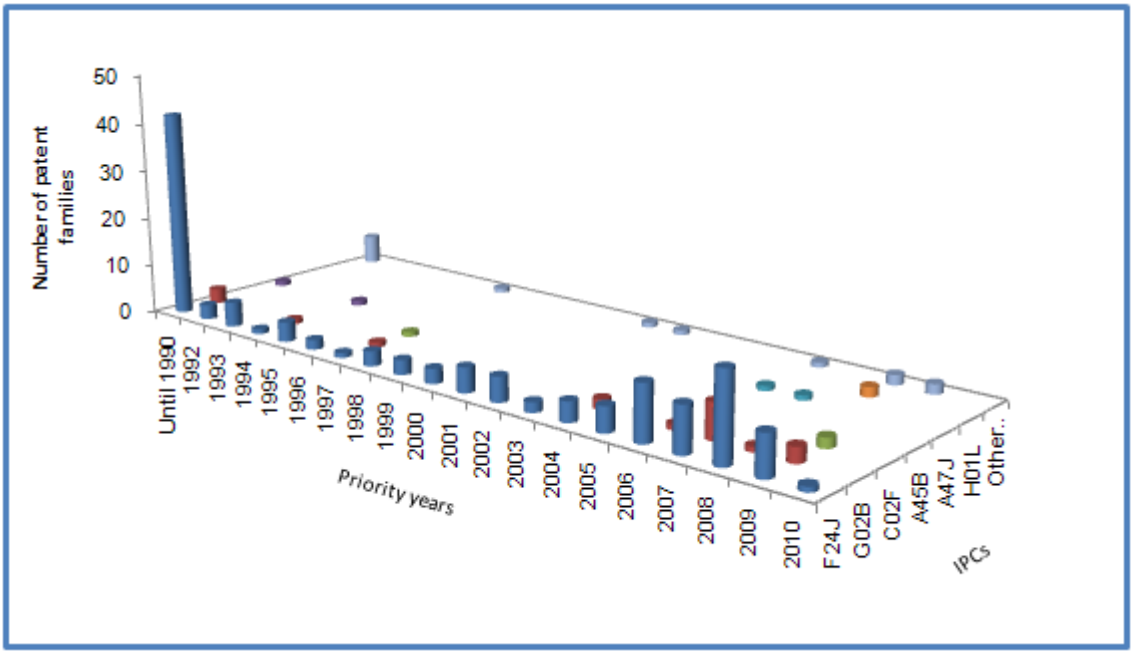
- The analysis shows patenting activity specifically pertaining to the second major segment i.e. components used only / also used in solar cooking applications. This analysis revealed a total of 176 patent family members.

- Among these patent family members, almost 70% (124 patent inventions) were first-filed after 1990, while patenting activity of the remaining 30% (52 patent inventions) started earlier in the period of 1950's.

- The highest patenting activity was recorded in the year 2008 with 22 patent inventions, followed by years 2007 and 2009 with 17 and 15 patent inventions respectively. No evidence for patent filing was found in the year 1991.

7.1.2 IPC Analysis across Priority years:

Graph 29: IPC analysis across priority years



Patent Dataset: 176 patent families

Table 8: Definitions

IPC	IPC Definitions[2]
F24J	PRODUCTION OR USE OF HEAT NOT OTHERWISE PROVIDED FOR
G02B	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS
C02F	TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE
A45B	WALKING STICKS; UMBRELLAS; LADIES' OR LIKE FANS) and A47J (KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES
A47J	KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR

- The analysis identified top six IPCs (having at least two patent family members) accounting for almost 92 % (162 patent family members) of the total 176 patent family members
- IPC (primary) F24J (PRODUCTION OR USE OF HEAT NOT OTHERWISE PROVIDED FOR) leads the IPC list with 134 patent family members (or 76% of the total 176 patent family

[2] http://www.wipo.int/ipcpub/

members) under which most of the patent family members were predominantly related to concentrator / reflector and solar tracking devices

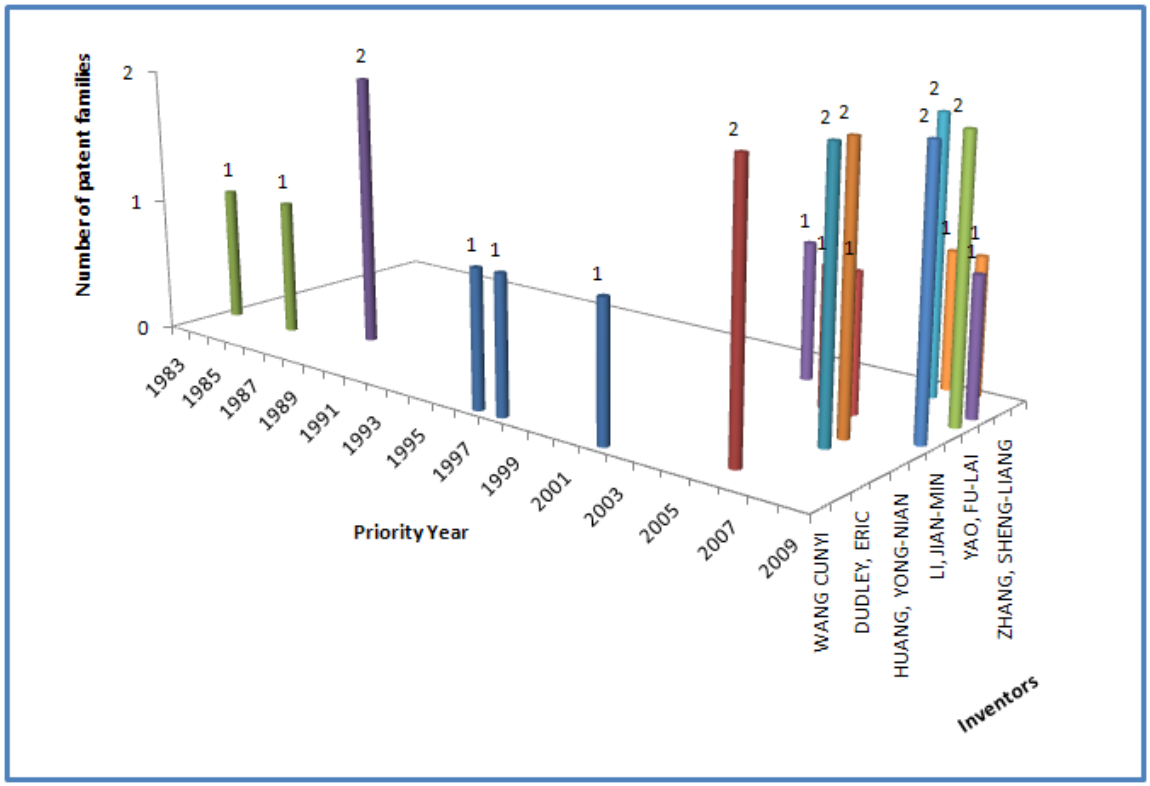
- IPC (primary) G02B (OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS) was the second leading IPC with 19 patent family members (or 11% of the total 176 patent family members) and explicitly on concentrator / reflector cluster

- IPC (primary) C02F (TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE) was the third leading IPC with three patent family members (or 2% of the total 397 patent family members). These patent family members were related to collector (with glass / lens arrangements) that used water for collecting the solar energy.

- IPCs (primary) A45B (WALKING STICKS; UMBRELLAS; LADIES' OR LIKE FANS);A47J (KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES) and H01L (SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR) occupied the next three leading IPC categories with two patent family members each

7.1.3 Prolific Inventor Analysis

Graph 30: Prolific Inventor Analysis



Patent Dataset: 176 patent families

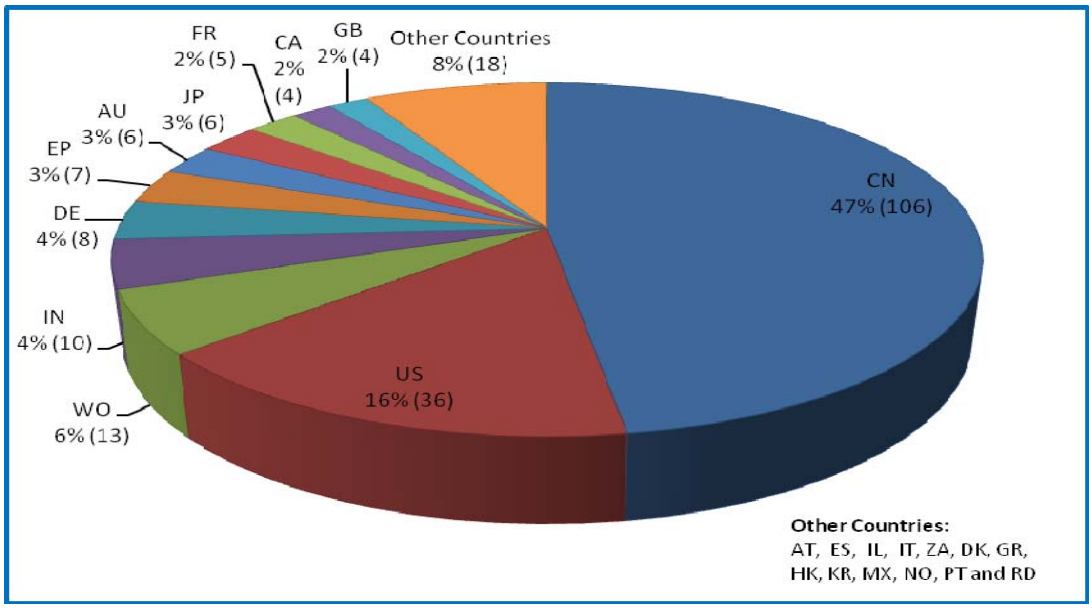
- An analysis of the inventors of the 176 patent family members identified about 12 prolific inventors having at least two or more patent family members each

- WANG CUNYI was the leading inventor with three patent inventions which were filed in the years 1997, 1998 and 2002. The remaining inventors (11 prolific inventors) shared the portfolio with two patent family members each

- In the year 2007 alone, seven patent inventions were filed by the inventors, which was followed by the year 2009 with five patent inventions

7.1.4 Geographical distribution

Graph 31: Geographical distribution



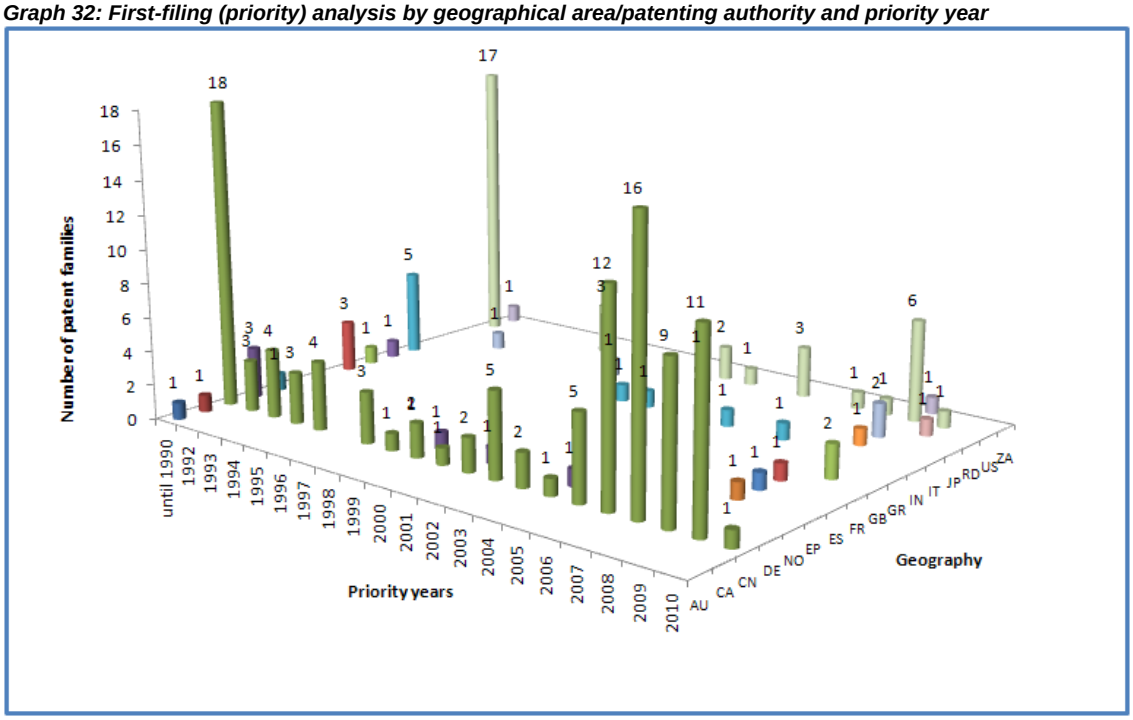
Patent Dataset: 223 patents / applications/ utility models

An analysis of the geographical distribution of the 223 patents/ applications (176 patent family members) revealed the following:

- A maximum of 48% (106 patents / applications) of the 223 patents/ applications were published in China (CN). Among them, utility model patents dominate the overall patent filings
- The United States (US) was the second leading country of origin contributing to 16% (36 patents / applications) of the 223 patents/ applications.
- 6% (13 PCT applications) were filed in the WIPO which was in the third position. 10 patents / applications were filed in India (IN) which had a share of 4% of overall patent filings.
- Germany (DE), Europe (JP), Australia (AU) and Japan (JP) France (FR) were other leading patent filling geographies sharing the portfolio with more than 2% in each geography

7.1.5 First-filing (priority) analysis by geographical area/patenting authority and priority year:

Graph 32: First-filing (priority) analysis by geographical area/patenting authority and priority year

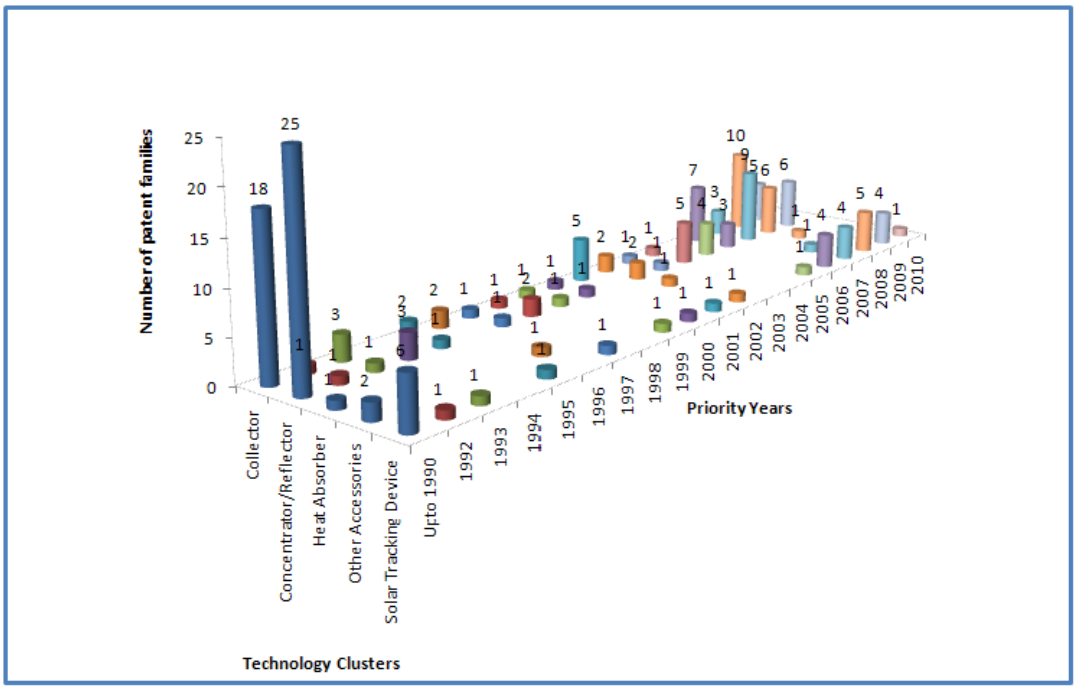


Patent Dataset: 176 patent families

- An analysis of the first filing across geographies showed that a maximum of 59% (103 patent inventions) of the 176 patent family members were first filed in China (CN). There was no first filing witnessed in the year 1996 in CN geography
- The US was the next leading patent issuing authority with a share of almost 20% (36 patent inventions) of the total patent family members.
- Other countries including India and Germany also played a significant role in the solar cooking components technology space with 9 and 7 patent inventions respectively.
- In an overall view, until 1990 US and CN were equally compatible with good number of first filings. After 2004 China started focusing much in this technology area with a larger number of first filings, whereas US lagged far behind China in first filing activity during these periods.

7.1.6 Technology clusters over priority year analysis:

Graph 33: Technology clusters over priority year analysis

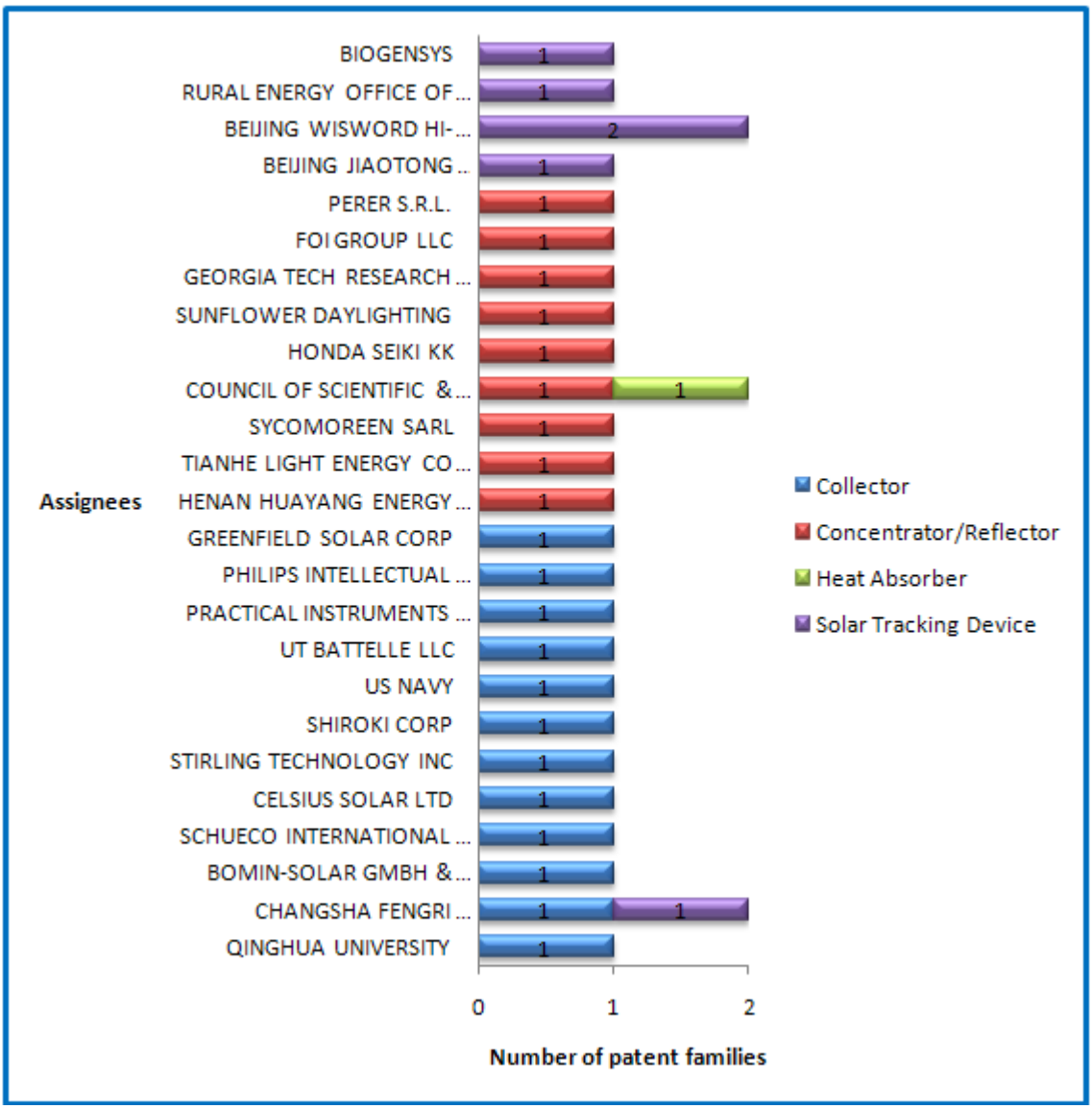


Patent Dataset: 176 patent families

- At the overall level, patenting activity in the solar cooking components segment can be traced back to 1950s. Since then there was a gradual increase until 1990. During this period nearly 30% (52 patent inventions) of patent filings was witnessed
- The patent filing activity was clearly evidenced in the period 2005-2009. During this period, nearly 16% (28 patent inventions) of patent filings occurred in the Concentrator/Reflector area
- When compared to other components' related patent filings, filings in the Concentrator/Reflector area dominated the portfolio with 72 patent inventions (over 40 %)
- Collector and Solar Tracking Devices contributed to 36% (64 patent inventions) and 18% (33 patent inventions) respectively

7.1.7 Technology clusters across leading assignees:

Graph 34: Technology clusters across leading assignees



Patent Dataset: 176 patent families

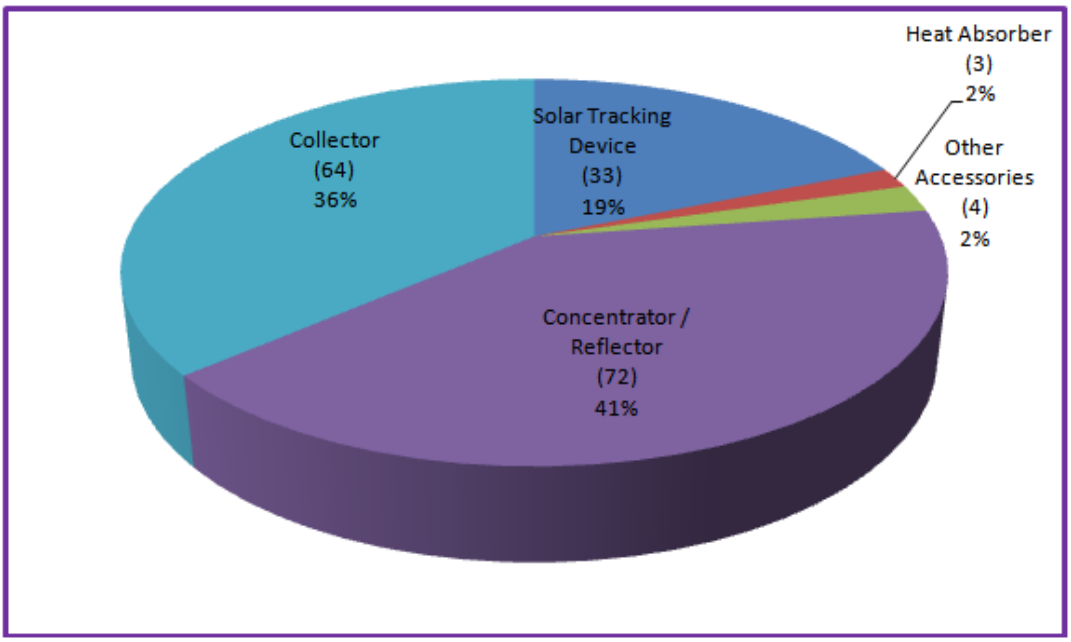
- On the whole, CHANGS FENGRI ELECTRIC GROUP, BEIJING WISWORD HI-TECH CO LTD and COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH were the major assignees with a maximum of two patent family members each
- CHANGS FENGRI ELECTRIC GROUP had one patent family member on collector and the other one on solar tracking devices. Further, the COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH had two patent family members focusing on absorbers and reflectors respectively. BEIJING WISWORD HI-TECH CO LTD had both its patent family members in the solar tracking area.
- The remaining assignees had their patenting activity with a single filing across the various components listed above.

7.2 Technical overview

The analysis revealed that 176 patent family members related to a variety of components that were only/also used in solar cooking applications. These 176 patent family members were further sub-clustered into different types of components viz.

- Concentrator/Reflector
- Collector
- Solar Tracking Device
- Heat Absorber and
- Other Accessories

Graph 35: Technical overview



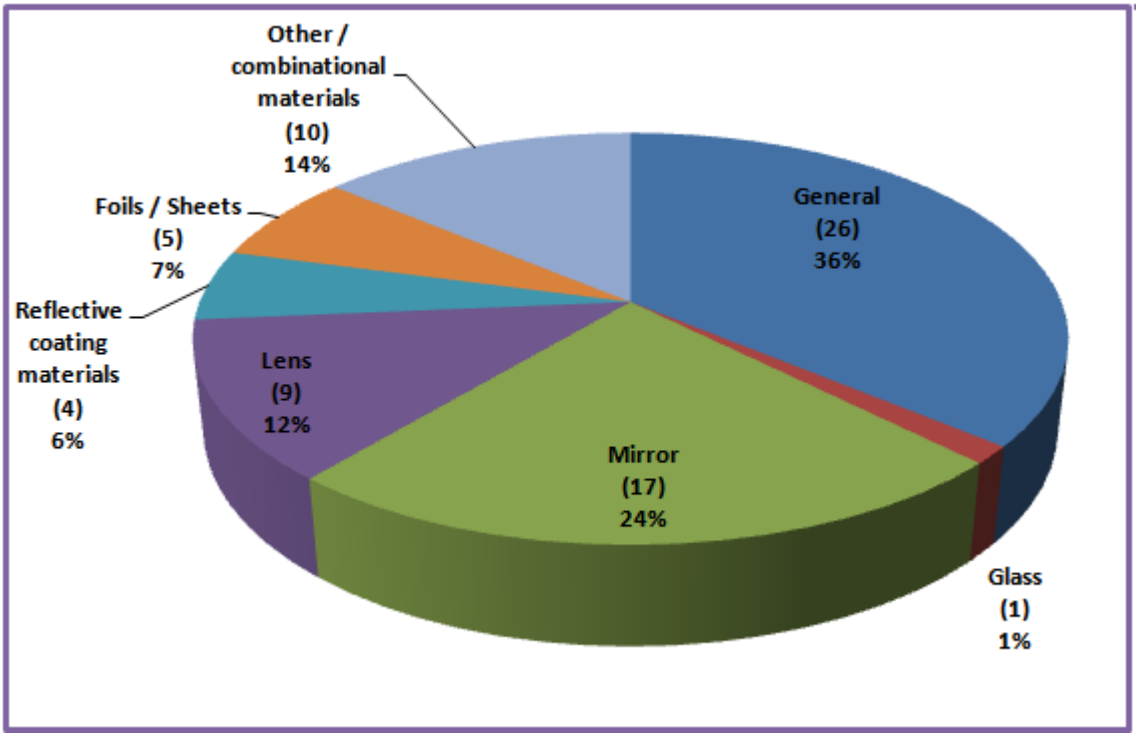
Patent Dataset: 176 patent families

The following section of the report discusses each of these solar cooking components in detail.

7.2.1 Concentrator/Reflector

Solar concentrators/reflectors are used to direct the solar energy into the cooking surface/area. In general, mirror and aluminum sheets, etc., are used for reflection and concentration of sun light.

Graph 36: Spread of concentrator/reflector materials



Patent Dataset: 72 patent families

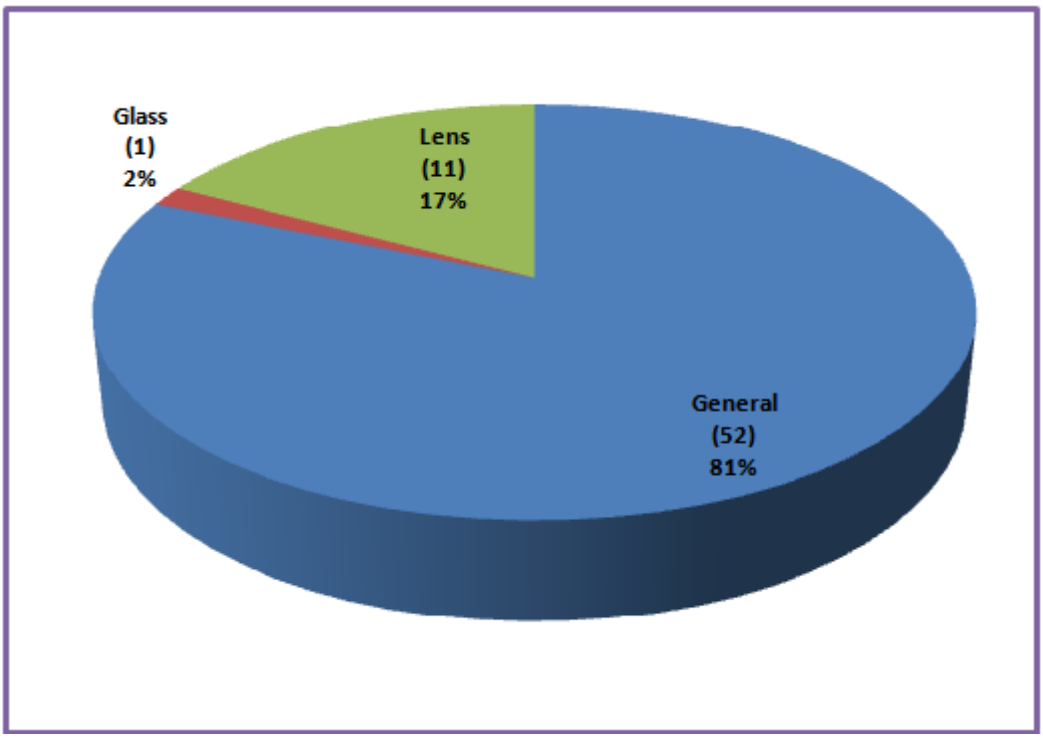
As indicated on the graph, 72 out of 236 patent family members disclosed about concentrator/reflectors.

- Based on the type of reflective objects / materials used, the above mentioned 72 patent family members were further sub clustered. Among these sub-clusters, mirrors dominated the portfolio with 17 patent family members, followed by other / combinational materials like pilable sheet, spary painted black sheets etc. with ten patent family members
- Furthermore, the usage of lens and foils/sheets as reflective medium was discussed in ten and five patent family members respectively. Similarly, the use of reflective coating materials was disclosed in four patent family members and glass reflector arrangement in a single patent family member
- The remaining 26 patent family members discussed general reflector arrangements/materials (without specifying the type of reflective material used)

7.2.2 Collector

Solar collectors are designed to collect heat by absorbing sunlight and then the collected heat is used for cooking/heating purposes.

Graph 37: Spread of collector materials



Patent Dataset: 64 patent families

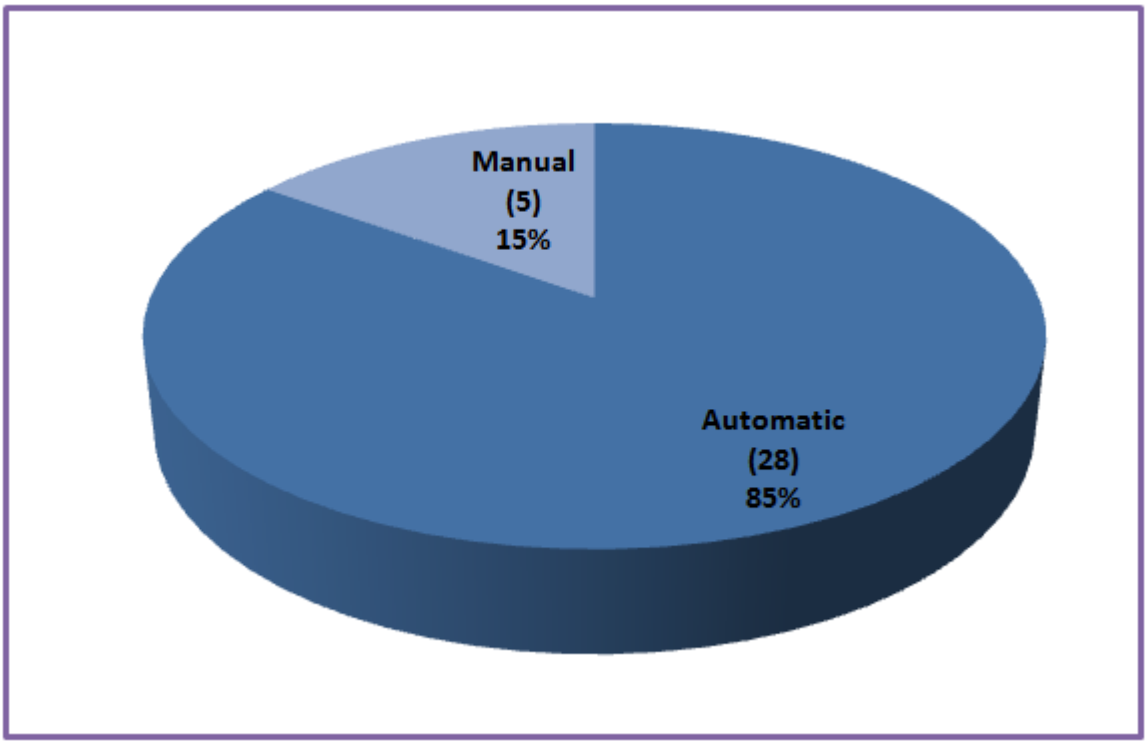
Among the 176 patent family members under this segment-II, 64 patents family members discussed about solar heat collector arrangements that are used only/also in solar cooking applications.

- 52 discussed general heat collector arrangements (i.e. without specifying the type of material/objects being used for the collector), 11 patent family members disclosed the use of lens as an efficient means of collecting solar heat and a single patent family member disclosed a glass heat collector.

7.2.3 Solar Tracking Device

Tracking devices are used to orient the solar cooker towards the sun continuously and maximize the effectiveness of cooking. Such a device will track/follow the sun's position throughout the day regardless of its location and aligns the cooker to focus the solar radiation accurately. Solar tracking devices may be automatic or manually operable.

Graph 38: Spread of solar tracking mechanism



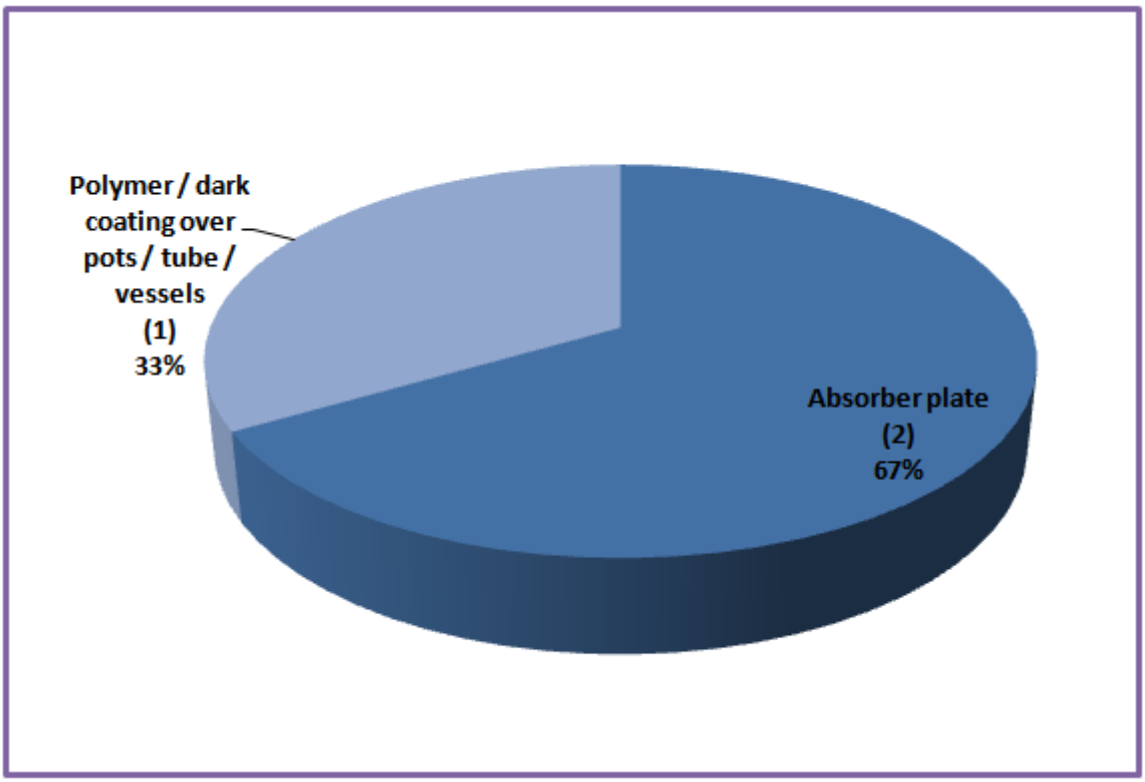
Patent Dataset: 33 patent families

- Among the resulted 176 patent family members under this segment-II, 33 patent family members explicitly disclosed about tracking mechanism used only/also in solar cooking applications. Out of these 33 patent family members, 28 discussed automatic solar tracking mechanisms which exclude human interventions and uses sun tracking sensor, tracking drive mechanisms, opto-electrical automatic tracking units etc.
- Only five patent family members disclosed manual solar tracking means such as manual tilting/adjusting methods, mechanical methods such as shaft rotation, use of driving belt and pulley arrangements etc.

7.2.4 *Heat absorber*

Heat absorbing devices are used to absorb the directed or reflected solar radiations and to convert them into longer wavelength heat energy.

Graph 39: Spread of heat absorber materials



Patent Dataset: three patent families

- Among the 176 patent family members under this major segment II, only three patents mainly disclosed about solar heat absorbing materials. The absorber plate technology was discussed in two patent family members, whereas the black/dark coating over vessels was discussed as a means for absorbing solar heat in single patent family member.

7.2.5 *Other accessories*

Other than major components, there were four patent family members which specifically disclosed about other accessories used only/also in solar cooking applications of 176 patent family members. These devices include cupboard, multifunctional square table arrangement, lock hinge mechanism and iron pan designed for multi applications etc.

8.0 Conclusion

The landscape analysis carried out to identify the patenting activity in solar cooking technology highlight the following:

- At an overall level, the patenting activity in this technology has been gradually increasing since 2003.
- The Chinese geography seems to be dominating the technology space. Surprisingly, the PCT route doesn't seem to be preferred.
- Similarly, the contribution of individual inventors in the solar cooking technology space is predominant when compared to Companies, Universities/Research Institutes etc.

Segment I - Complete solar cooking systems/solutions

- Reflected concentration heating technology is more predominantly used for solar cooking technology because of its easy construction and efficiency. Most of the commercial products available in market used reflected concentration heating techniques. Patenting activity in this technique has been sustained across the years.
- Trapped heating has been used from ancient times as most of the patenting activity in this technique happened before the ‘90's. The patent filings in this technique however witnessed a slowdown in the period 1990-2008. However, a slow revival is beginning to be seen in the year 2009.
- Indirect heating methodology is predominantly used in indoor cooking and a significant number of patents was filed in the year 2008
- Direct solar absorption technique occupies the last position among all the heating technologies with minimal number of patent filings

Segment II - Components only/also for solar cooking applications

- Nearly one third of the patent family members clustered under this segment discussed different components used only for solar cooking applications,
- The remaining two thirds’ discussed the components that may also be used for solar cooking applications along with other applications such as solar power generation, multi fuel cooking etc.
- Most of the patent family members predominantly disclosed the concentrator/reflector component arrangement.

ASSUMPTIONS & LIMITATIONS

- The data required for the analysis was retrieved using Thomson Innovation database and the same was presented in the format as available in Thomson innovation database
- The bibliographic Information of each family was downloaded from the Thomson innovation database and Scope is not responsible for any errors caused due to the inadequate updating of the database
- Only the primary IPC of the representative member of a patent family was used for statistical analysis purposes
- The IPC/USC format as available in the Thomson innovation database was followed
- The number of patent family members indicates the number of inventions filed by a company. It will not include the count of continuation/divisional/continuation-in part patents/patent applications filed for a single invention in various geographies. The priority date for each of the patent family members has been retrieved through Micropatent/Thomson innovation database
- The dataset that has been considered for analysis include only published patents/patent applications. Those that have been filed in recent years but not published in the public domain will not come under the scope of the assignment
- Primarily a PCT member is considered as representative member, In the absence of a PCT member, any family member published in English was considered
- Hyperlinks for patents have been provided to ESPACENET or any other free patent database for the representative member of each relevant patent family based on availability.
- No hyper linking was provided for the INPADOC family members given in the report
- All the inventors of a patent have been considered for the prolific inventor analysis
- Grant count includes all published utility/design/divisional/continuation/continuation-in-part grants. A family-reduced dataset was not adopted for grant analysis
- With regards to the clustering of patent documents by technology, a multiple clustering approach was adopted i.e. there is a possibility that a single patent document can simultaneously belong to multiple technical clusters
- For major segment II (components only / also for solar cooking applications), only few types of patenting trend analysis have been carried out due to the minimal dataset count

- Under major segment II - components only / also for solar cooking applications, the patent family members are clustered only based on the predominant feature / component / embodiment they disclosed
- In case of geographic analysis, geographies with the least number of patent filings were grouped under the “other geographies” category
- The citation count for a single family represents the sum of forward citations obtained by each member of the respective family
- The count of patent family members projected in an individual geography represents only the number of relevant inventions filed in the respective geography and does not include the different applications filed for a single invention i.e. the number represents the number of inventions instead of number of applications/publications
- The assignee analysis did not consider any M&A activity that could have happened in the industry. Hence, all patents considered for analysis have been represented by the original identity of the assignee only
- A list of patent documents pertaining to “Solar water heater” and “Title alone” category was enclosed in MS-EXCEL spread sheet
- For non-English patent documents, the analysis was carried out only based on the Derwent abstract retrieved from DWPI
- The analysis was performed based on the narrowed down selected combinational strategy.

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