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An Across Data Sources Environmental Scanning mechanism for Issue Analysis

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Abstract

This study proposes a mechanism that provides researchers an efficient way to conduct environmental scanning from different data sources with consideration of the consistency between research issue and retrieved data. The international trend reports, foresight databases, scientific literatures, US patents, R&D investment and human resources databases are linked by this study. Furthermore, each of the developing trends, technologies from international trend reports, foresight databases are categorized into societal demand and technology support respectively. As a result, an overall view of world societal demands will be unveiled, with possible solutions. This article proposes Taiwan as a case study by using, the government R&D investment database, literature & US patent database and human resource database as proxies to reflect the responses and output when facing the challenges in such a rapidly changing world. The solar energy, one of the renewable energy technologies, is adopted as a target in the case to examine the effects of proposed environmental scanning mechanism. The world future energy development will be illustrated from both social demand and technology perspectives, and the hierarchical technology tree of solar energy is further discussed together with Taiwan's R&D input and output.

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Outline

- Problem statement
- Research approach
- Application case
- Conclusions

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Problem statement

- S&T Policy makers need information support for policy making, including:
  - Mega trends around the world (including foresight survey results)
  - Policies or important programs of other countries
  - R&D resources (including funding, human capital, S&T literature & patents)
- Most of above mentioned information can be obtained from databases, except policies or important programs of other countries
  - Query criteria may be quite different across databases: keyword based search suitable for literature database, while technological classification codes (ex. IPC) for search patents! [1]
  - It takes a lot of effort to define data retrieving rules for various databases.
- When facing rapid responses on a large number of issues, this would be a big problem!

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Problem statement

- Keywords-based information retrieving mechanism only provides researchers with an integrated query interface to for enquiries across different databases.
  - The J-Global system approach proposed by Japan Science and Technology Agency (JST) is one of the most famous cases.[2]
- Because of the different characteristics of different data sources, the same keywords do not necessarily mean the same outputs across different data sources.
  - For example, high performance computing (HPC) technology contains different definitions in different database. Some define HPC as grid computing and others may well emphasize the computing power of single computer or mainframe.

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Why do we have to solve it?

- Who are we?

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Why do we have to solve it?

- As a S&T policy think tank, we have to provide policy makers and foresight practitioners an solution for evidence-based decision making.
  (For the purpose of conducting an overall environmental scanning on certain issues or research topics)
- Hence a strategic intelligence approach (ie. to collect information across data sources in a systematic way) is desperately needed
  - Shorter response time
  - Efficient processes

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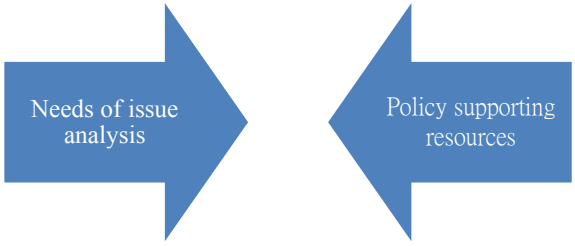
The works we have done in this study

- Integrating the databases inside the STPI to provide issue-related information effectively
  - Developing an cross-database querying mechanism
  - Providing standard statistical analysis results from different databases



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Policy supporting resources in STPI

- Delphi topics
  - Foresight Delphi topics from Japan, Korea, China,…
- Government Research Bulletin (GRB)[3]
  - Management of founded S&T projects from ministries of Taiwan (R&D investment)
- National Profiles of Human Resources in Science and Technology (NPHRST)[4]
  - Provide basic S&T HR statistics of Taiwan
- Scientific literatures and Patent databases
  - Literatures and patents are seen as R&D output indicators; STPI owns almost 30 years collection of scientific literatures and US patents from 1976 till present.

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Approach

- This study provides an effective mechanism to retrieve information among databases. Researchers can conduct certain issue analyses from foresight database to R&D investment, patent and scientific literature databases, human resources database systematically, and thus, an overall environmental scanning of certain S&T issue or topic can be revealed.

The overall view of developing trends and technologies of certain S&T foresight topic is conducted via horizon scanning toward international developing trends (R&D).

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Approach

- The technological functions described in Delphi survey topics are assigned a subclass level of International Patent Classification (IPC) code [5]
- Since each technological function has been assigned an IPC code, the technology developing trend (i.e. patent set for patent analyses) of Delphi survey topics can be done.
- The journal articles cited by patents retrieved in previous steps are collected as the data set for the study of the scientific developing trend relevant to Delphi survey topics. Thus, current developments of next generation technologies of Taiwan and the rest of world can be unveiled.
- To compare the above results with R&D inputs (funding & human resource) of Taiwan, the R&D funding and human resource databases are also connected with above mentioned databases (via author key, author ID).

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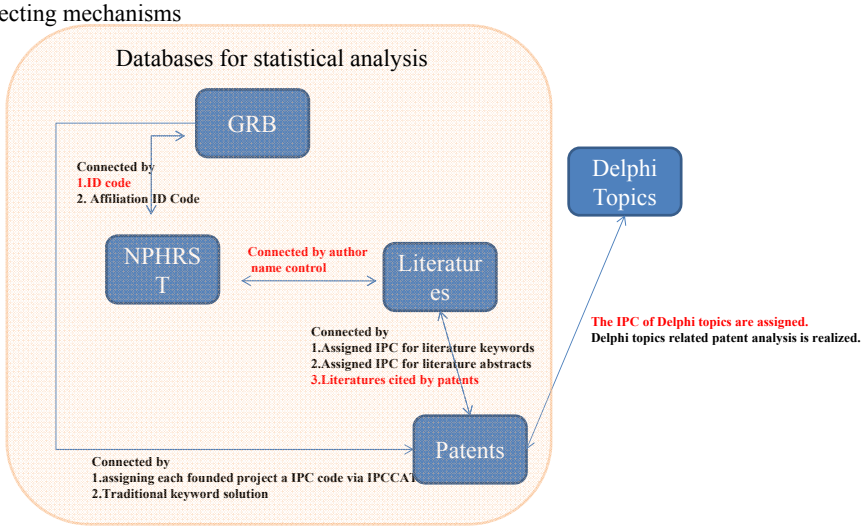
Approach

Connecting mechanisms



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Remark: The description in red is the main connecting fields of this study.

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Application case – Solar energy

- Solar energy related Delphi topics from Korea 3rd , Japan 8th & 9th foresight are selected.
- IPCs identified in selected Delphi topics

IPC	Description
H01J	ELECTRIC DISCHARGE TUBES OR DISCHARGE LAMPS
H02N	ELECTRIC MACHINES NOT OTHERWISE PROVIDED FOR
H03K	PULSE TECHNIQUE
C01B	NON-METALLIC ELEMENTS; COMPOUNDS THEREOF
H02K	DYNAMO-ELECTRIC MACHINES
H04B	TRANSMISSION
F24J	PRODUCTION OR USE OF HEAT NOT OTHERWISE PROVIDED FOR
B32B	LAYERED PRODUCTS, i.e. PRODUCTS BUILT-UP OF STRATA OF FLAT OR NON-FLAT, e.g. CELLULAR OR HONEYCOMB, FORM
E04B	GENERAL BUILDING CONSTRUCTIONS; WALLS, e.g. PARTITIONS; ROOFS; FLOORS; CEILINGS; INSULATION OR OTHER PROTECTION OF BUILDINGS
F03G	SPRING, WEIGHT, INERTIA, OR LIKE MOTORS; MECHANICAL-POWER-PRODUCING DEVICES OR MECHANISMS, NOT OTHERWISE PROVIDED FOR OR USING ENERGY SOURCES NOT OTHERWISE PROVIDED FOR
H02J	CIRCUIT ARRANGEMENTS OR SYSTEMS FOR SUPPLYING OR DISTRIBUTING ELECTRIC POWER; SYSTEMS FOR STORING ELECTRIC ENERGY
H03G	CONTROL OF AMPLIFICATION
G05D	SYSTEMS FOR CONTROLLING OR REGULATING NON-ELECTRIC VARIABLES
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR
F01D	NON-POSITIVE-DISPLACEMENT MACHINES OR ENGINES, e.g. STEAM TURBINES

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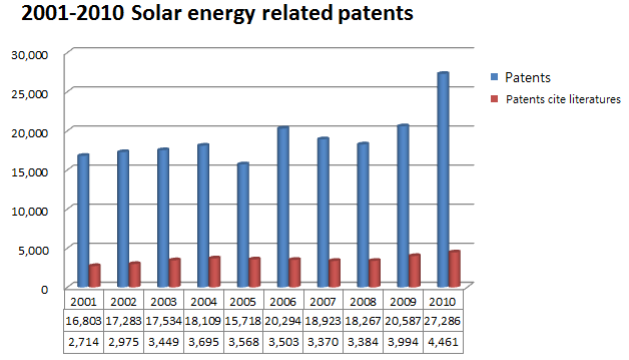
Application case – Solar energy

- The US patent number of energy technology related Delphi topics in 2001-2010



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Application case – Solar energy

- Science linkage of solar energy related patents
  - There are about 35,000 solar energy related patents cite scientific literatures during 2001 to 2010, US has the strongest science linkage among all countries (the share of all citing literatures patents is 61.31%)

Country	Patents	Percentage
UNITED STATES	21,170	61.31%
JAPAN	6,694	19.39%
GERMANY	1,404	4.07%
SOUTH KOREA	1,020	2.95%
FRANCE	675	1.95%
TAIWAN	654	1.89%
CANADA	552	1.60%
UNITED KINGDOM	411	1.19%
SWEDEN	260	0.75%
NETHERLANDS	260	0.75%

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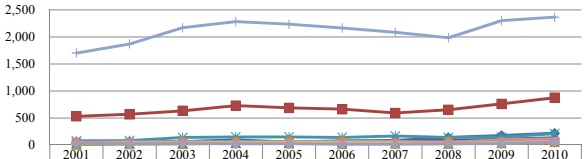
Application case – Solar energy

- Understanding trends of overall science linkage among countries

Top 10 high Science Linkage Countries



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SOUTH KOREA	50	61	63	95	53	78	84	140	176	220
JAPAN	532	569	633	729	687	663	593	652	761	875
NETHERLANDS	6	15	19	33	29	21	27	22	33	55
TAIWAN	34	32	31	37	54	57	80	87	109	133
GERMANY	78	82	139	150	150	141	167	139	149	209
CANADA	46	40	61	58	66	70	40	57	60	54
UNITED STATES	1,702	1,870	2,171	2,283	2,236	2,166	2,087	1,986	2,303	2,366
FRANCE	50	61	58	56	51	69	68	51	98	113
UNITED KINGDOM	23	42	42	47	49	46	40	34	45	43
SWEDEN	32	25	28	23	24	15	13	25	26	49

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- Below shows the top 10 assignees with solar energy related patents (high science linkage)

No.	AssigneeName	#of patents	Percentage
1	Micron Technology, Inc.	2,439	6.85%
2	International Business Machines Corporation	852	2.39%
3	Semiconductor Energy Laboratory Co., Ltd.	787	2.21%
4	Applied Materials, Inc.	654	1.84%
5	Intel Corporation	609	1.71%
6	Kabushiki Kaisha Toshiba	599	1.68%
7	Infineon Technologies AG	429	1.21%
8	Canon Kabushiki Kaisha	397	1.12%
9	Matsushita Electric Industrial Co., Ltd.	380	1.07%
10	Samsung Electronics Co., Ltd.	341	0.96%

Micron Technology shares 6.85% of patents that cite literatures

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Application case – Solar energy

- Knowledge sources of solar energy technology related patents
  - Literatures from US are cited most in solar energy patents (47.44%)
  - The share of US and Japan is about 60%

No.	Country	Cited literatures	Percentage
1	US	96834	47.44%
2	Japan	24733	12.12%
3	Germany	12116	5.94%
4	UK	9882	4.84%
5	France	6985	3.42%
6	South Korea	5131	2.51%
7	Canada	4609	2.26%
8	China	4290	2.10%
9	Switzerland	3665	1.80%
10	Italy	3620	1.77%
11	Netherlands	3597	1.76%
12	Taiwan	3083	1.51%
13	Sweden	3027	1.48%
14	Finland	2589	1.27%
15	Russia	2125	1.04%
16	Australia	1723	0.84%
17	Belgium	1690	0.83%
18	Israel	1619	0.79%
19	India	1551	0.76%
20	Spain	1328	0.65%

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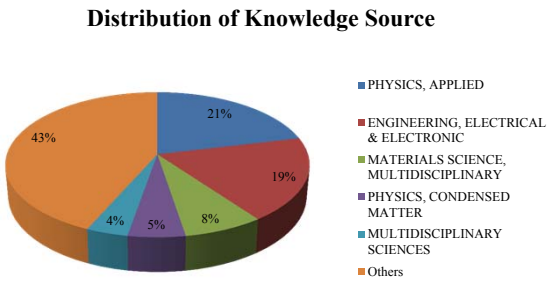
- Literatures of Physics, Applied; Engineering, Electrical & Electronic are main knowledge source of solar energy related technology
  - More resources may invest in this two areas…



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- The overall trends and information of world solar energy Delphi topics are revealed
  - Important country, main area, main player…
- The R&D input of Taiwan can also be shown by connecting Delphi topics with GRB and HR Databases

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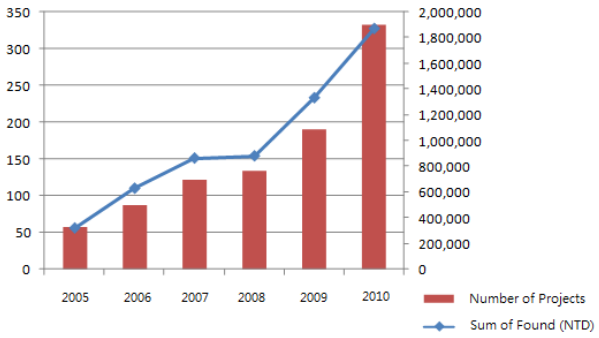
Application case – Solar energy

- The number of projects and R&D founding of Taiwan is climbing during 2005-2010.



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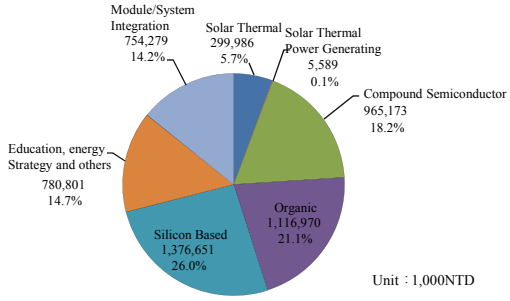
- Main R&D topics founded by our government are silicon based, organic and compound semiconductor solar cell



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- Industry categories distribution of researchers with PhD degree related to solar energy

Age Distribution	<35		35-44		45 -54		55-64		65-69		>=70		N/A		Total	
Category	count	%	count	%	count	%	count	%	count	%	count	%	count	%	count	%
Manufacture	8	2.7	10	3.3	2	0.7	8	2.7	1	0.3	0	0.0	6	2.0	35	11.7
Power, gas, steam provider	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	1	0.3	2	0.7
ICT	0	0.0	1	0.3	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	2	0.7
R&D	11	3.7	17	5.7	6	2.0	9	3.0	0	0.0	0	0.0	1	0.3	44	14.7
Education	15	5.0	71	23.7	72	24.1	35	11.7	4	1.3	3	1.0	6	2.0	206	68.9
Services	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	1	0.3
N/A	2	0.7	3	1.0	1	0.3	0	0.0	0	0.0	2	0.7	1	0.3	9	3.0
Total	36	12.0	102	34.1	83	27.8	53	17.7	5	1.7	5	1.7	15	5.0	299	100.0

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Most HR located in Public/Private Universities

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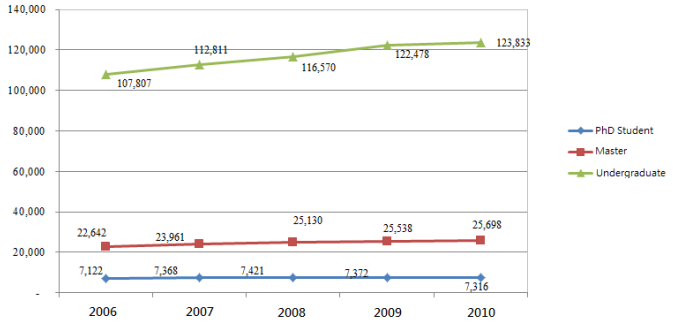
- Student count of solar energy technology related department of university between 2006-2010



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The number of undergraduate students is growing in this years

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Application case – Solar energy

- Solar energy technologies related patents are growing around the world
- US and Japan are important countries in this topic
  - Number of patent hold
  - Main scientific knowledge sources
- Taiwan also puts a lot of R&D resources in this topic

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Conclusions

- At present, researchers or policy makers often adopt team based cooperation with various experts and keywords-based information retrieving when conducting environmental scanning.
  - It can bring us precise, accurate and complete information/data in return.

However, it is still a daunting task with high time and communication costs.

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Conclusions

- With our method, we can get useful results from rich sources conveniently and efficiently.
- This study provides a linkage among different data sources via IPC codes, citation behavior, and others
  - It can help policy makers and researchers to reduce the efforts of collecting and analyzing data when conducting an environmental scanning for issues they are interested in.
  - Regarding practical sense for foresight researchers, the revealed results produced from above mentioned approach can be the very first step of foresight process (a horizon scanning of environmental scanning as background information related to the discussed foresight subjects).

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