"Visualization" of decarbonization patent technologies toward the carbon neutrality by 2050

The movement toward carbon neutrality is accelerating around the world. As of September 1, 2021, 123 countries and regions have committed to virtually zero emissions of carbon dioxide or greenhouse gases by 2050 ※1. China, the world's largest emitter thereof, has also announced that it will achieve virtually zero emissions of greenhouse gases by 2060 ※2. Japan has also set a new greenhouse gas reduction target for FY2030, aiming to reduce greenhouse gas emissions by 46% from FY2013 ※3.

The challenge is not a cost to economic growth, but a growth opportunity for a transformation of industrial structure, economic and social reform, and investment. The world has entered a new game-changing era.

It is a great opportunity for many Japanese companies skilled at energy-saving technology to improve their presence in the world. In order for Japanese companies to take advantage of this opportunity, it is essential to **understand patent information closely related to innovation.**

The Japio AI Research Center has **successfully established an AI model to estimate patent applications related to decarbonization technologies from patent specifications.** This document explains the method of the visualization.

※1　Council for National and Local Decarbonization (1st), Document2, Attachment2 https://www.cas.go.jp/jp/seisaku/datsutanso/dai1/siryou2-3.pdf
※2　Expert Panel on Climate Change (1st), Document4-3 https://www.cas.go.jp/jp/seisaku/kikouhendoutaisaku/dai1/siryou4-3.pdf
※3　Green Growth Strategy through Achieving Carbon Neutrality in 2050 (June 18, 2021)
https://www.meti.go.jp/press/2021/06/20210618005/20210618005-3.pdf

■ Method for establishing an AI model

The visualization is conducted using an AI method called BERT, which was released by Google. While BERT is an AI trained to read ordinary text like Wikipedia or novels, it was specially trained to read patent documents at Japio AI Research Center.

Furthermore, classifiers corresponding to the Cooperative Patent Classification (CPC)*4 main group*6 of "Y02" and "Y04"*5 were added to the BERT after training. Then, by reading patent documents related to each CPC, we have established an AI model that can estimate a patent application related to decarbonization technologies.

High-quality training data were created by manually checking and selecting the appropriate patent documents that belong to various technologies related to decarbonization, from documents with Y02 or Y04 .

Finally we compiled each estimated patent document into three fields of “Energy-related industries,” “Transportation/manufacturing-related industries," and “Household/office work-related industries.” These fields are described as the important fields where growth is expected in the "Green Growth Strategy through Achieving Carbon Neutrality in 2050"*3 (June 18, 2021) released by the Cabinet Secretariat.

※4 Cooperative Patent Classification (CPC) : It is an extension of the International Patent Classification (IPC) and jointly managed by the EPO and the US Patent and Trademark Office. It is divided into nine sections, A-H and Y, and has about 250,000 subdivisions.
※5 Definition of Y02 : TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE
Definition of Y04 : INFORMATION OR COMMUNICATION TECHNOLOGIES HAVING AN IMPACT ON OTHER TECHNOLOGY AREAS
※6 The CPC is hierarchically organized into sections (e.g. Y), classes (e.g. Y02), subclasses (e.g. Y02B), and main groups (e.g. Y02B10), with the main group representing up to six digits of the eight-digit classification information.

■ Results

As a result of AI estimation, the estimated CPC and estimated value are calculated. Estimates take from 0 to 1, and the closer the value is to 1, the more accurate the estimate becomes. As shown in Table 1, we succeeded in estimating the main groups equivalent to the CPC(Y02, Y04) assigned in the patent publications.

Table 1： Estimation results (EP publications with CPC were used as an example.)

Description in the publication (Excerpt)	Estimated CPC*1 (Y02, Y04 only)	Industrial field
This application relates to the field of power technologies……. The photovoltaic system includes an adapter circuit, a first photovoltaic string,……. The first photovoltaic string and the second photovoltaic string are configured to provide electric energy for the controller…….	Y02E10 (correct*2)	Energy-related industries
This application provide a load threshold determining method and apparatus. The method includes:……..; obtaining an evaluation value corresponding to each preselected load threshold in a first periodicity, where each evaluation value is used to evaluate key performance indicator KPI information and energy saving information of the cell;…….	Y02D30 (correct)	Transportation/manufacturing-related industries
Rechargeable, Energy-Saving and Multifunctional LED Lamp. The lamps currently available in the market are always embarrassed by the single-purpose use, low degree of portability…… consists of the lamp holder, retractable link rod, housing, shade, LED bead, fixer, PCB and lithium battery. ……. The application locations of the product include stores, hotels, showrooms, emporiums, offices, warehouses, public places and residential houses.	Y02B20 (correct)	Household/office work-related industries

＊1：CPC with an estimated value greater than 0.50

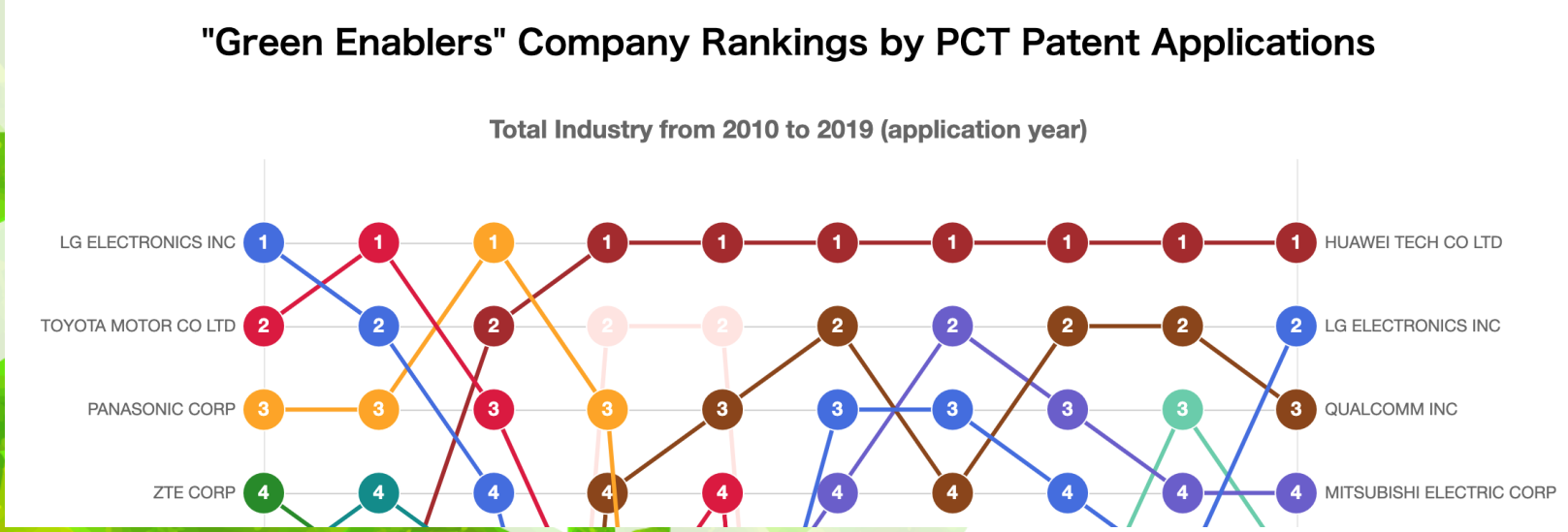
＊2：”correct” means that the estimated CPC is the same as the CPC in EP publications

■ “Green Enablers” Company rankings (1)

The Japio AI Research Center publishes various rankings on our website: three industries of **“Energy-related industries,” “Transportation/manufacturing-related industries,”** and **“Household/office work-related industries,”** and **"total"** thereof, as a ranking of companies that have patent applications related to decarbonization technologies.

The table below shows a portion of the **total ranking** based on the applications filed with the Japan Patent Office. This is a ranking of companies which have decarbonization-related patent applications filed with the JPO from 2010 to 2019, with annual transition for the top 10 applicants.

Table 2: an example of “Green Enablers” company ranking



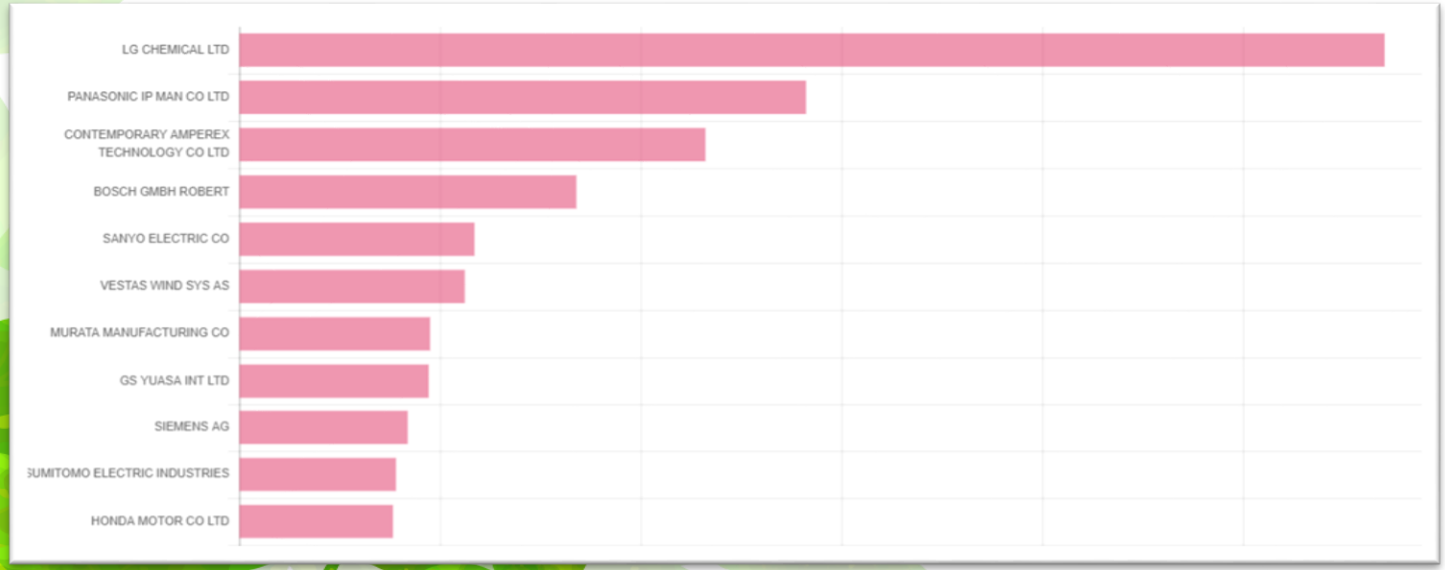
■ “Green Enablers” Company rankings (2)

For more detailed data, we have also published a company ranking in 2019. The table below is an example of the company ranking. The estimated CPC and values were calculated for each patent publication filed in 2019, and the scores (total estimated value in each patent publication) were tabulated by industry and applicant.

For the rankings, see URLs below (in Japanese):

- JPO Patent Applications
https://transtool.japio.or.jp/work/data/ranking_top20_jp.html
- PCT Patent Applications
https://transtool.japio.or.jp/work/data/ranking_top20_wo.html

Table 3: An example of “Green Enablers” company ranking



■ “Green Enablers” Company rankings (3)

We also provide "Green Enablers" rankings by "Japio-Decarbonization Patent Index", an index that can evaluate "Green Enablers", independent of the number of patent applications. (in Japanese)

For the rankings, see URLs below (in Japanese):
https://transtool.japio.or.jp/work/data/carbon_index_ranking.pdf

Table 4: An example of “Green Enablers” company ranking

総合上位 100社（1～40）

	出願人名	指数※	公開件数		出願人名	指数※	公開件数
1	プライムアースＥＶエナジー株式会社	0.9778	45	21	青島海爾洗衣机有限公司	0.7838	74
2	三洋電機株式会社	0.9679	156	22	マツダ株式会社	0.7837	726
3	サンデン・オートモーティブクライメイトシステム株式会社	0.9667	30	23	ルノーエス．ア．エス．	0.7835	328
4	古河電池株式会社	0.9620	79	24	ヤマハ発動機株式会社	0.7829	304
5	株式会社ＧＳユアサ	0.9555	292	25	日本電気硝子株式会社	0.7744	266
5	ダイムラー・アクチェンゲゼルシャフト	0.9457	92	26	株式会社ＫＯＫＵＳＡＩＥＬＥＣＴＲＩＣ	0.7710	131
7	ローム・アンド・ハース・エレクトロニック・マテリアルズ・コリア・リミテッド	0.9286	56	27	株式会社神鋼環境ソリューション	0.7674	43
8	株式会社ナイルワークス	0.9167	48	28	日野自動車株式会社	0.7656	209
9	三菱自動車工業株式会社	0.9104	268	29	メタウォーター株式会社	0.7632	38
10	株式会社キャタラー	0.8889	36	30	株式会社ブイ・テクノロジー	0.7561	41
11	ビーエーエスエフコーポレーション	0.8857	35	31	日揮触媒化成株式会社	0.7556	45
12	スズキ株式会社	0.8761	468	32	東京エレクトロン株式会社	0.7537	877
13	ｗｉｎｇ株式会社	0.8431	51	33	株式会社ディスコ	0.7533	839
14	ジョンソン、マッセイ、パブリック、リミテッド、カンパニー	0.8333	30	34	キヤノントッキ株式会社	0.7500	64
15	三星エスディアイ株式会社	0.8197	61	35	東芝マテリアル株式会社	0.7353	34
16	起亞自動車株式会社	0.8125	32	36	本田技研工業株式会社	0.7299	2880
17	井関農機株式会社	0.8039	357	37	トヨタ自動車株式会社	0.7202	5351
18	株式会社ＳＵＢＡＲＵ	0.8008	718	38	三菱マヒンドラ農機株式会社	0.7115	104
19	ＦＤＫ株式会社	0.7969	64	39	東海旅客鉄道株式会社	0.7111	45
20	東京応化工業株式会社	0.7863	131	40	株式会社アドヴィックス	0.7090	134