Electronic Supplementary Material

The change in AEPT patent applications from year t to year t+1 can be represented as

$$\Delta P_{\mathrm{AEPT}} = P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t} = \Delta P_{\mathrm{TP}} + \Delta P_{\mathrm{TD}} + \Delta P_{\mathrm{RE}} + \Delta \mathrm{P}_{\mathrm{RS}} + \Delta P_{\mathrm{ES}} + \Delta P_{Y}. \quad \text{(A1)}$$

The determinants on the right hand of Eq. (A-1) can be calculated by using Eqs. (A2) – (A7).

$$\Delta P_{\mathrm{TP}} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln \mathrm{TP}^{t+1} - \ln \mathrm{TP}^{t} \right). \quad \text{(A2)}$$

$$\Delta P_{\mathrm{TD}} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln \mathrm{TD}^{t+1} - \ln \mathrm{TD}^{t} \right). \quad \text{(A3)}$$

$$\Delta P_{\mathrm{RE}} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln \mathrm{RE}^{t+1} - \ln \mathrm{RE}^{t} \right). \quad \text{(A4)}$$

$$\Delta P_{\mathrm{RS}} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln \mathrm{RS}^{t+1} - \ln \mathrm{RS}^{t} \right). \quad \text{(A5)}$$

$$\Delta P_{\mathrm{ES}} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln \mathrm{ES}^{t+1} - \ln \mathrm{ES}^{t} \right). \quad \text{(A6)}$$

$$\Delta P_{Y} = \sum_{i=1}^{n} \frac{P_{\mathrm{AEPT}}^{t+1} - P_{\mathrm{AEPT}}^{t}}{\ln P_{\mathrm{AEPT}}^{t+1} - \ln P_{\mathrm{AEPT}}^{t}} \left(\ln Y^{t+1} - \ln Y^{t} \right). \quad \text{(A7)}$$

Therefore, changes in the number of patent applications for alternative energy production technology (ΔP_{AEPT}) are decomposed into six effects which are entitled as technology priority effect (ΔP_{TP}), low-carbon degree effect (ΔP_{TD}), R&D efficiency effect (ΔP_{RE}), R&D share effect (ΔP_{RS}), economic structure effect (ΔP_{ES}), and economic scale effect (ΔP_{Y}).

Similarly, the number of patent applications of ECT (P_{ECT}) is decomposed as

$$P_{\mathrm{ECT}} = \sum_{i=1}^{n} \frac{P_{\mathrm{ECT},i}}{P_{\mathrm{LC},i}} \times \frac{P_{\mathrm{LC},i}}{P_i} \times \frac{P_i}{\mathrm{RD}_i} \times \frac{\mathrm{RD}_i}{Y_i} \times \frac{Y_i}{Y} \times Y$$

$$= \sum_{i=1}^{n} \mathrm{TP}'_i \times \mathrm{TD}_i \times \mathrm{RE}_i \times \mathrm{RS}_i \times \mathrm{ES}_i \times Y. \quad \text{(A-8)}$$

The determinants of the changes in the number of patent applications of ECT patent applications can be obtained using

$$\Delta P_{\text{ECT}} = P_{\text{ECT}}^{t+1} - P_{\text{ECT}}^{t} = \Delta P_{\text{TP}}' + \Delta P_{\text{TD}}' + \Delta P_{\text{RE}}' + \Delta P_{\text{RS}}' + \Delta P_{\text{ES}}' + \Delta P_{Y}', \quad \text{(A-9)}$$

where ΔP_{ECT} refers to the change in the number of ECT patent applications, and PECT refers to the number of ECT patent applications. The variables on the right-hand side of Eq. (A9) are technology priority effect ($\Delta P_{\text{TP}}'$), low-carbon degree effect ($\Delta P_{\text{TD}}'$), R&D efficiency effect ($\Delta P_{\text{RE}}'$), R&D share effect ($\Delta P_{\text{RS}}'$), economic structure effect ($\Delta P_{\text{ES}}'$), and economic scale effect ($\Delta P_{Y}'$). The calculation processes of the six effects are similar to that of Eqs. (A-2) – (A-7).

The total number of LC patent applications can be decomposed as

$$P_{\text{LC}} = \sum_{i=1}^{n} \frac{P_{\text{LC},i}}{P_i} \times \frac{P_i}{\text{RD}_i} \times \frac{\text{RD}_i}{Y_i} \times \frac{Y_i}{Y} \times Y = \sum_{i=1}^{n} \text{TD}_i \times \text{RE}_i \times \text{RS}_i \times \text{ES}_i \times Y. \quad \text{(A-10)}$$

Then, the change of LC patent applications is the sum of five effects, expressed as

$$\Delta P_{\text{LC}} = P_{\text{LC}}^{t+1} - P_{\text{LC}}^{t} = \Delta P_{\text{TD}}'' + \Delta P_{\text{RE}}'' + \Delta P_{\text{RS}}'' + \Delta P_{\text{ES}}'' + \Delta P_{Y}'', \quad \text{(A-11)}$$

where P_{LC} refers to the number of LC patent applications, and ΔP_{LC} refers to the change in the number of LC patent applications. The variables on the right-hand side of Eq. (A-11) are low-carbon degree effect ($\Delta P_{\text{TD}}''$), R&D efficiency effect ($\Delta P_{\text{RE}}''$), R&D share effect ($\Delta P_{\text{RS}}''$), economic structure effect ($\Delta P_{\text{ES}}''$), and economic scale effect ($\Delta P_{Y}''$). The calculation process of the five effects are similar to that of Eqs. (A-3) – (A-7).

The indicator of technology priority is defined as the number of patent applications of a specific low-carbon energy technology divided by the total number of patent applications of the low-carbon energy technology. The value of the indicator increases if the patent application number of a specific low-carbon energy technology increases more quickly than that of all low-carbon energy technologies. This will contribute to the increasing number of patent applications of the specific low-carbon energy technology, ceteris paribus. The technology priority effect reflects the degree of priority assigned by inventors to a specific low-carbon energy technology.

The indicator of low-carbon degree is defined as the total number of patent applications of the low-carbon energy technology divided by the total number of patent applications. The value of this indicator increases if the patent application number of the low-carbon energy technology increases more quickly than the number of total patent applications. This will contribute to the increasing number of patent applications of a specific low-carbon energy technology, ceteris paribus. The low-carbon degree effect reflects the degree of research resources distribution on low-carbon innovation.

The indicator of R&D efficiency is defined as the total number of patent applications divided by R&D expenditure. R&D expenditure can be taken as the input while the generation of patents can be considered as the output in the process of research and development. The value of this indicator increases if the total number of patent applications per unit of R&D expenditure increases. The improvement of R&D efficiency will contribute to the increasing number of patent applications of a specific low-carbon energy technology, ceteris paribus. The R&D efficiency effect captures both allocative and technical efficiencies of the research process of enterprises.

The indicator of R&D share is defined as the share of R&D expenditure in industrial output. The value of this indicator increases if there are more economic resources concentrated on R&D activities. This will contribute to the increasing number of patent applications of a specific low-carbon energy technology, ceteris paribus. The R&D share effect reflects the degree of industrial attention and industrial scientific input to the development of science and technology.

The indicator of economic structure is defined as the share of industrial output of each province/autonomous region/municipality in the total amount of China's industrial output value. Economic income is the major impetus for R&D expenditure because R&D activities of companies strongly depend on the corporate financial situation. Ceteris paribus, if the share of industrial output of a province/autonomous region/municipality which is active in R&D activities increases, then the number of patent applications of a specific low-carbon energy technology will increase. The economic structure effect reflects the variation of the distribution of industrial production capacity and economic resources for R&D activities among provinces/autonomous regions/municipalitiesin China.

The indicator of economic scale is defined as China's gross industrial output which is the sum of industrial output in China's 30 provinces/autonomous regions/municipalities. Generally, economic activity is related to R&D activity. Thus, the economic scale in China's industrial sector has an indirect impact on the number of new patents publication, including those related to low-carbon energy technologies. Ceteris paribus, the expansion of economic scale will lead to the increasing number of patent applications of a specific low-carbon energy technology. The economic scale effect reflects the financial ability to support R&D activities and thus the low-carbon energy technology innovation in China's industrial sector.

Table S1 Classification of China's 30 provinces/autonomous regions/municipalities

No.	Province/Autonomous regions/Municipality	Region	No.	Province/Autonomous regions/Municipality	Region
1	Beijing	Eastern	16	Henan	Central
2	Tianjin	Eastern	17	Hubei	Central
3	Hebei	Eastern	18	Hunan	Central
4	Shanxi	Central	19	Guangdong	Eastern
5	Inner Mongolia	Western	20	Guangxi	Western
6	Liaoning	North-eastern	21	Hainan	Eastern
7	Jilin	North-eastern	22	Chongqing	Western
8	Heilongjiang	North-eastern	23	Sichuan	Western

9	Shanghai	Eastern	24	Guizhou	Western
10	Jiangsu	Eastern	25	Yunnan	Western
11	Zhejiang	Eastern	26	Shaanxi	Western
12	Anhui	Central	27	Gansu	Western
13	Fujian	Eastern	28	Qinghai	Western
14	Jiangxi	Central	29	Ningxia	Western
15	Shandong	Eastern	30	Xinjiang	Western

Table S2 Categories of low-carbon energy technology according to the IPC green inventory

Technology group	Technology subgroup
Alternative energy production	(1) Biofuels (2) Integrated gasification combined cycle (3) Fuel cells (4) Pyrolysis or gasification of biomass (5) Harnessing energy from manmade waste (6) Hydro energy (7) Ocean thermal energy conversion (8) Wind energy (9) Solar energy (10) Geothermal energy (11) Other production or use of heat not derived from combustion (12) Using waste heat (13) Devices for producing mechanical power from muscle energy
Energy conservation	(1) Storage of electrical energy (2) Power supply circuitry (3) Measurement of electricity consumption (4) Storage of thermal energy (5) Low energy lighting (6) Thermal building insulation, in general (7) Recovering mechanical energy