The ESG-Innovation Disconnect: Evidence from Green Patenting

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Motivation:
How prevalent is ESG Investing?

- As of 2020, sustainable investing represents more than 33 percent of the $51.4 trillion in U.S. assets under management. Compared to 2017, sustainable and impact investing has increased by more than 42% (USSIF 2020).

- Several contributors to this growth
  - Awareness about climate related factors
  - Mandates by governments
    - 2015 guidance issued by the Department of Labor which allowed fiduciaries to incorporate environmental, social, and governance (ESG) factors into their investment decision.

- The implementation of ESG is often done by either avoiding certain categories categorically (such as Tobacco (27%), Weapons (16%), Fossil Fuel (11%), Gambling (11%)), or embracing certain industries (such as Local Economic Benefit (22%), Clean Tech (14%), Environment (11%), etc.).
    - ESG Scores

Motivation:
Arguments for/against ESG Investing

- **Preferences:** Investors willing to sacrifice an amount of risk-adjusted return in order to allow the fund to achieve returns with aligned ESG focus; or alternatively, pay more for a fund that promises the same ex-ante risk-return dynamics while delivering aligned ESG investment.

- **Beliefs:** A micro-founded, belief-based view of ESG investing could exist irrespective of the investor's actual preferences for ESG.

  - Customers: If consumers value products that are ESG compliant, they might be willing to pay a premium for these, or firms might collect a monopolistic rent on production if it were a salient product differentiation attribute.

  - Employees: If talented workers preferred companies following ESG principles, it could also be a mechanism to attract higher quality factors of production (such as human capital), or pay less for these factors. In these ways, good ESG behavior might be a source of comparative advantage that – if the market didn't fully impound – could result in favorable future return dynamics.

vs.

- Constrained portfolio maximization run by ESG-constrained fund managers is dominated by the unconstrained maximization run by other managers, resulting in likely underperformance in the risk-return space.

Motivation:
Evidence on the Effect of ESG Investing

- Realized performance: The academic evidence on the realized performance of ESG-focused funds is decidedly mixed.
- **Effect on firm behavior: <u>There is limited systematic evidence that firms receiving disproportional amounts of capital from ESG flows have outperformed in any measurable way.</u>**
- Given this, our understanding of whether ESG investment flows impact innovation which can help us solve environmental problems is incomplete.
- We investigate *who* produces green patents, or innovation that helps address climate change and other environmental challenges, and who are the most influential of these green patent producers.
  - *Incentives*
  - *Capability*
- Whether the capital of investors who desire to allocate capital toward ESG objectives actually do end up investing in these producers.

Sample

- USPTO: We use two large datasets that capture the complete universe of patents from 2008 through **2020** in order to identify the universe of green patenting activity (Patent Citation and Patent Assignment databases).

- For much of our analysis on firm characteristics of patenting entities, we concentrate on publicly traded firms, due to there being rich, publicly available measures of firm characteristics, external activities, income, profitability, patent holdings, fund flows.

- ESG ranking data (Sustainalytics ESG Ratings) – post 2008.
  - Now replicated with MSCI.

US006490999B1

(12) **United States Patent**
Boys

(10) **Patent No.: US 6,490,999 B1**
(45) **Date of Patent: Dec. 10, 2002**

(54) **COLLAR APPARATUS ENABLING SECURE HANDLING OF A SNAKE BY TETHER**

(75) Inventor: **Donald Robert Martin Boys**, Bella Vista, CA (US)

(73) Assignee: **Central Coast Patent Agency, Inc.**, Aromas, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/942,485**

(22) Filed: **Aug. 29, 2001**

(51) **Int. Cl.**[7] **A01K 27/00**

(52) **U.S. Cl.** **119/792**; 119/654; 119/769; 119/795; 119/856; 119/864; 119/865

(58) **Field of Search** 119/792, 760, 119/769, 795, 815, 816, 864, 865, 714, 821, 654, 856

5,829,058	A	*	11/1998	Dicker et al.	2/227
6,101,981	A	*	8/2000	Friend et al.	119/860
6,156,001	A	*	12/2000	Frangi et al.	602/19
6,182,293	B1	*	2/2001	Mustin	2/161.1
6,192,835	B1	*	2/2001	Calhoun et al.	119/792
6,205,956	B1	*	3/2001	Dickie et al.	119/792

OTHER PUBLICATIONS

Donald Robert Martin Boys, Collar Apparatus Enabling Tethering and Walking of a Snake Disclosure Doument No. 497,031, Jul. 18, 2001, USPTO.

* cited by examiner

Primary Examiner—Charles T. Jordan
Assistant Examiner—Bret Hayes
(74) *Attorney, Agent, or Firm*—Donald R. Boys; Central Coast Patent Agency, Inc.

(57) **ABSTRACT**

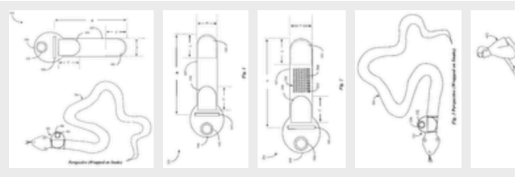
A collar for collaring a snake has an elongated collar section forming a physical collar when wrapped around the body portion of the snake. The collar further has a support section

Collar apparatus enabling secure handling of a snake by tether

Abstract

A collar for collaring a snake has an elongated collar section forming a physical collar when wrapped around the body portion of the snake. The collar further has a support section for supporting an attachment mechanism for accepting attachment of a tether and a connector system comprising at least two components affixed to strategic portions of the collar section for securing the collar in place around the body portion of the snake. The length of the collar section is such that a portion thereof overlaps itself when fitted around the snake providing an adjustable interface containing separate components of the connector system whereby mating the connector components together. secures the collar in place on the snake. In one embodiment the collar apparatus further includes a concertina movement-neutralization device for reducing concertina movement through the collar.

Images (6)



Classifications

A01K27/001 Collars

View 2 more classifications

US6490999B1

United States

Download PDF

Find Prior Art Similar

Inventor: Donald Robert Martin Boys

Current Assignee : SoundStarts Inc

Worldwide applications

2001 • US 2002 • WO EP AU

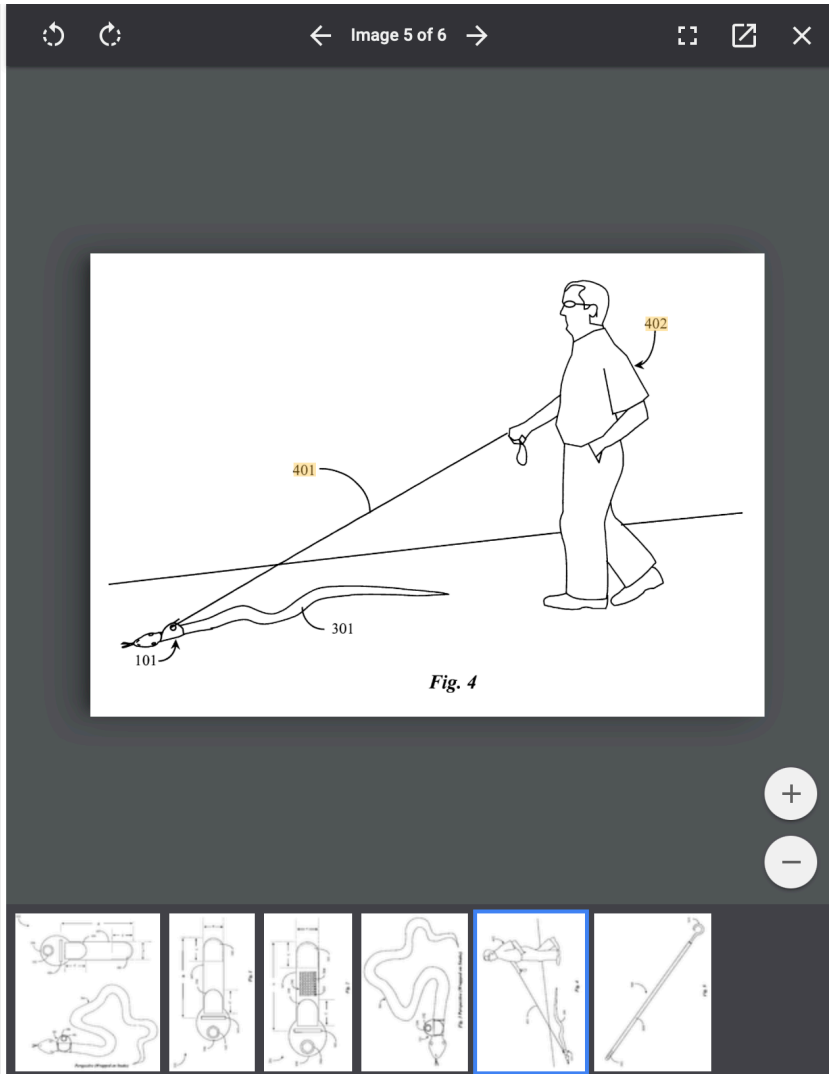
Application US09/942,485 events

2001-08-29	Application filed by Central Coast Patent Agency Inc
2001-08-29	Priority to US09/942,485
2002-12-10	Application granted
2002-12-10	Publication of US6490999B1
2021-08-29	Anticipated expiration
Status	Expired - Fee Related

Show all events

Info: Patent citations (17), Non-patent citations (1), Cited by (5), Legal events, Similar documents, Priority and Related Applications

External links: USPTO, USPTO PatentCenter, USPTO Assignment



This area was updated. Please refer to the CPC Notices of Changes and Notices of Editorial Corrections for more information.

CPC

D A01K

COOPERATIVE PATENT CLASSIFICATION

ANIMAL HUSBANDRY; CARE OF BIRDS, FISHES, INSECTS; FISHING; REARING OR BREEDING ANIMALS, NOT OTHERWISE PROVIDED FOR; NEW BREEDS OF ANIMALS

NOTE

This subclass covers:

- equipment for the care, culture or rearing of all animals, or for obtaining their products, unless provided for elsewhere,e.g. milking A01J, shoeing animals A01L, veterinary devices A61D, culture of animal cells C12M, C12N;
- methods of breeding animals or new animal breeds.

WARNING

In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

- ~~Animal husbandry in general, especially cattle-raising~~

D - **A01K 1/00** **Housing animals; Equipment therefor**

D - A01K 1/0005 . {Stable partitions (devices for fastening animals A01K 1/06; pasturing enclosures ~~A01K 3/00~~)}

D A01K 1/0011 . . {Cubicle partitions}

D - A01K 1/0017 . . {Gates, doors}

D A01K 1/0023 . . . {Sorting gates}

D A01K 1/0029 . . . {Crowding gates or barriers}

What are Green Patents?

- We follow the guidelines the Organization for Economic Co-operation and Development (OECD) created for the same purpose.
- Patents that are related to environmental technologies are classified into various broad environmental technology categories including: *environmental management*, *water related adaptation technologies*, *biodiversity protection and ecosystem health*, *climate change mitigation technologies related to energy generation*, and *waste-water treatment or waste management*.

4. CLIMATE CHANGE MITIGATION technologies related to ENERGY generation, transmission of distribution	Y02E
4.1. RENEWABLE ENERGY GENERATION	Y02E10
4.1.1. Wind energy	Y02E10/70
– Wind turbines with rotation axis in wind direction: blades or rotors, components or gearbox, control of turbines, generator, nacelles, onshore and offshore towers – Wind turbines with rotation axis perpendicular to the wind direction – Power conversion electric or electronic aspects; for grid-connected applications; concerning power management inside the plant, e.g. battery (dis)charging, operation, hybridisation	Y02E10/70-766
4.1.2. Solar thermal energy	Y02E10/40
– Tower concentrators; Dish collectors; Fresnel lenses; Heat exchange systems; Trough concentrators – Conversion of thermal power into mechanical power, e.g. Rankine, Stirling solar thermal engines; Thermal updraft – Mountings or tracking	Y02E10/40-47
4.1.3. Solar photovoltaic (PV) energy	Y02E10/50
– PV systems with concentrators – Material technologies: CuInSe2 material PV cells; Dye sensitized solar cells; Solar cells from Group II-VI materials; Solar cells from Group III-V materials; Microcrystalline silicon PV cells; Polycrystalline silicon PV cells; Monocrystalline silicon PV cells; Amorphous silicon PV cells; Organic PV cells – Power conversion electric or electronic aspects: for grid-connected applications; concerning power management inside the plant, e.g. battery (dis)charging, operation, hybridisation; Maximum power point tracking [MPPT] systems	Y02E10/50-58
4.1.4. Solar thermal-PV hybrids	Y02E10/60
4.1.5. Geothermal energy	Y02E10/10
– Earth coil heat exchangers; Compact tube assemblies, e.g. geothermal probes – Systems injecting medium directly into ground, e.g. hot dry rock system, underground water	Y02E10/10-18

What are Green Patents?

United States Patent [19]
Amick

[11] **4,235,643**
[45] **Nov. 25, 1980**

[54] **SOLAR CELL MODULE**

[75] Inventor: **James A. Amick**, Princeton, N.J.
[73] Assignee: **Exxon Research & Engineering Co.**, Florham Park, N.J.

[21] Appl. No.: **920,691**
[22] Filed: **Jun. 30, 1978**
[51] **Int. Cl.**[3] **H01L 31/04**
[52] **U.S. Cl.** **136/246**; 136/251
[58] **Field of Search** ..... 136/89 PC, 89 EP, 89 H

[56] **References Cited**
U.S. PATENT DOCUMENTS

3,973,994	8/1976	Redfield	136/89
4,116,718	9/1978	Yerkes et al.	136/89 PC

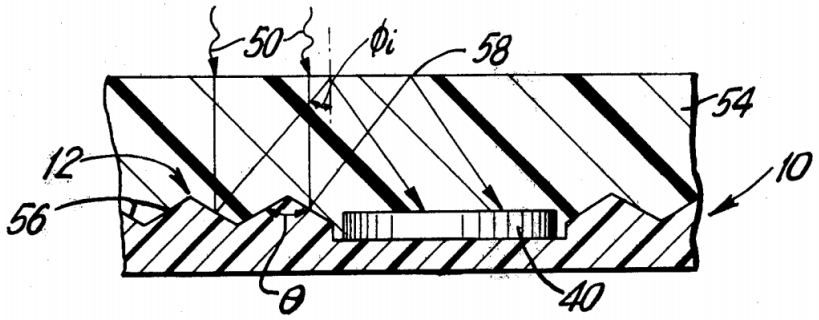
Primary Examiner—Aaron Weisstuch
Attorney, Agent, or Firm—Joseph J. Dvorak

[57] **ABSTRACT**

A solar cell module is provided having a plurality of circular solar cells arrayed on a support structure in which at least the land areas between the cells have facets with light reflecting surfaces. An optical cover medium couples the facets and the cells. Importantly the angular relationship of the facet surfaces is such that light impinging thereon will be reflected upwardly into the optical medium and then internally reflected downwardly toward an active cell area thereby effectively increasing the output of the module.

19 Claims, 6 Drawing Figures

Exxon published one of the first, and most influential, patents on solar cell technology

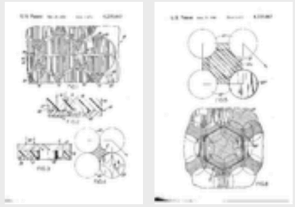


Solar cell module

Abstract

A solar cell module is provided having a plurality of circular solar cells arrayed on a support structure in which at least the land areas between the cells have facets with light reflecting surfaces. An optical cover medium couples the facets and the cells. Importantly the angular relationship of the facet surfaces is such that light impinging thereon will be reflected upwardly into the optical medium and then internally reflected downwardly toward an active cell area thereby effectively increasing the output of the module.

Images (2)



Classifications

- **H01L31/0547** Optical elements directly associated or integrated with the PV cell, e.g. light-reflecting means or light-concentrating means comprising light concentrating means of the reflecting type, e.g. parabolic mirrors, concentrators using total internal reflection
- H01L31/048 Encapsulation of modules
- *Y02E10/52* PV systems with concentrators

US4235643A
United States

Download PDF | Find Prior Art | Similar

Inventor: James A. Amick

Current Assignee : BP Solar International LLC , Solar Power Corp

Worldwide applications

1978 • ~~US~~

Application US05/920,691 events

1978-06-30 • Application filed by Exxon Research and Engineering Co

1978-06-30 • Priority to US05/920,691

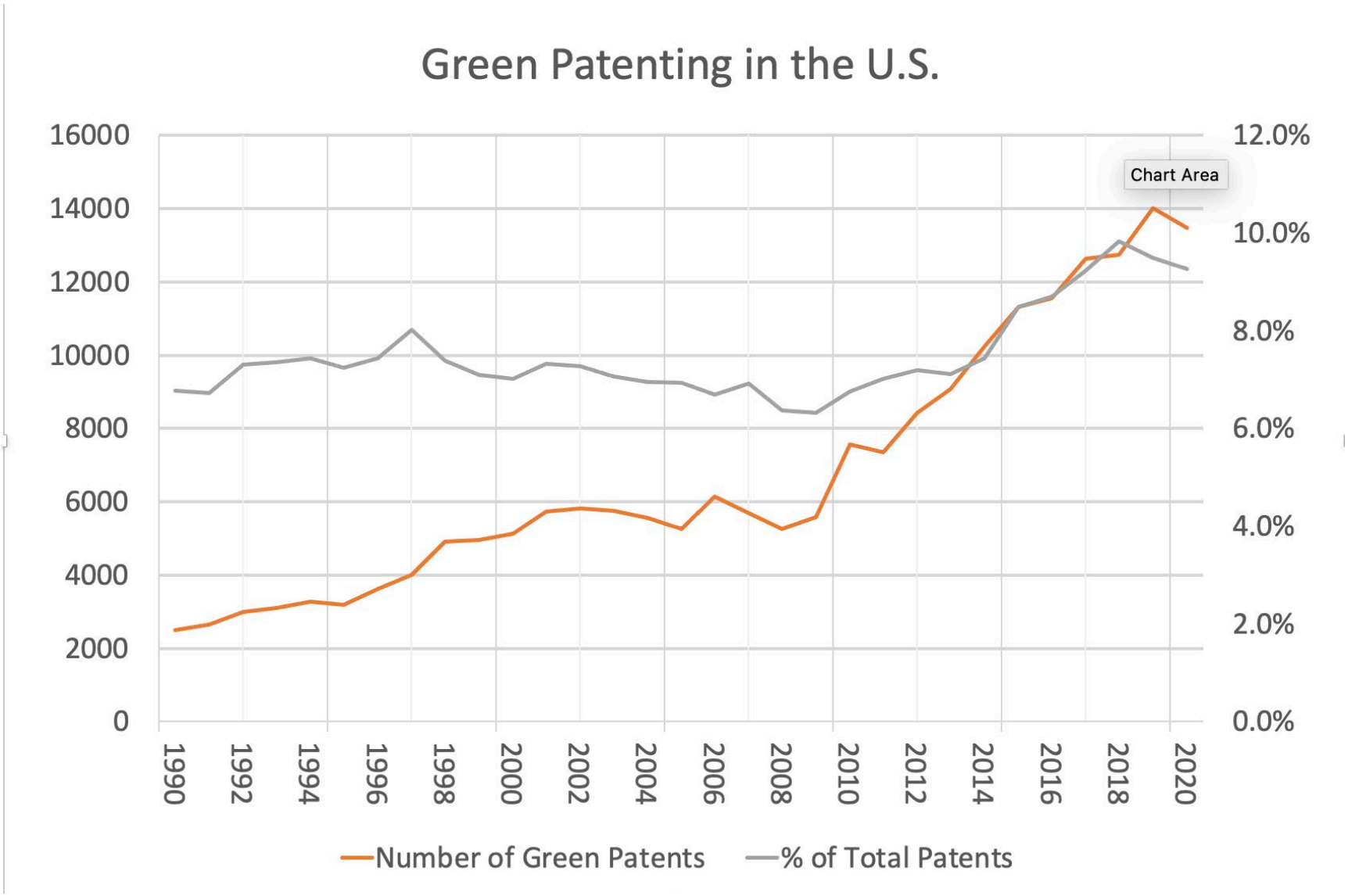
1980-11-25 • Application granted

1980-11-25 • Publication of US4235643A

1984-08-13 • Assigned to SOLAR POWER CORPORATION

1995-01-17 • Assigned to AMOCO/ENRON SOLAR

1998-06-30 • Anticipated expiration


Green Patenting in the U.S.
16000
14000
12000
10000
8000
6000
4000
2000
0
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Chart Area
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Number of Green Patents
% of Total Patents

Top 50 Green Patent Producers

Company Name	Total green patents	Rank	Company Name	Total green patents	Rank
GENERAL ELECTRIC CO	7520	1	BOEING CO	743	25
HONDA MOTOR CO LTD	4685	2	MOTOROLA SOLUTIONS INC	712	26
PANASONIC CORP	4576	3	**BP PLC**	**631**	**27**
HITACHI LTD	3921	4	**CONOCOPHILLIPS**	**629**	**28**
FORD MOTOR CO	2633	5	IONIS PHARMACEUTICALS INC	621	29
DUPONT DE NEMOURS INC	2617	6	**CHEVRON CORP**	**614**	**30**
UNITED TECHNOLOGIES CORP	2302	7	BASF SE	604	31
GENERAL MOTORS CO	2118	8	**US OIL CO**	**595**	**32**
NISSAN MOTOR CO LTD	2084	9	DELPHI TECHNOLOGIES PLC	585	33
CATERPILLAR INC	1712	10	NEC CORP	549	34
EXXON MOBIL CORP	**1670**	**11**	APPLIED INDUSTRIAL TECH INC	548	35
SONY CORP	1640	12	PFIZER INC	546	36
HONEYWELL INTERNATIONAL INC	1631	13	APTIV PLC	542	37
SIEMENS AG	1486	14	BAYER AG	527	38
INTL BUSINESS MACHINES CORP	1469	15	FUJIFILM HLDGS CORP	418	39
SANYO ELECTRIC CO LTD	1315	16	INTEL CORP	417	40
VIACOMCBS INC	1240	17	CHRYSLER CORP	401	41
ROYAL DUTCH SHELL PLC	**1199**	**18**	MICRON TECHNOLOGY INC	398	42
DAIMLER AG	1038	19	LOCKHEED MARTIN CORP	395	43
PARKER-HANNIFIN CORP	990	20	LINDE PLC	392	44
CANON INC	974	21	EASTMAN KODAK CO	364	45
KONINKLIJKE PHILIPS NV	903	22	APPLIED MATERIALS INC	359	46
AIR PRODUCTS & CHEMICALS INC	863	23	ROCKWELL AUTOMATION	355	47
CUMMINS INC	804	24	LG DISPLAY CO LTD	346	48
BOEING CO	743	25	DEERE & CO	337	49
MOTOROLA SOLUTIONS INC	712	26	VERIZON COMMUNICATIONS INC	336	50

Energy Sector (SIC): 10 (Metal, Mining), 12 (Coal Mining), 13 (Oil & Gas Extraction), 14 (Nonmetallic Minerals, Except Fuels), 29 (Petroleum & Coal Products), or 49 (Electric, Gas, & Sanitary Services).

Findings

1. A large fraction of this recent green patenting is not driven by highly rated ESG firms, firms that are commonly favored by ESG funds, but instead by firms that are explicitly excluded from ESG funds investment universe.

2. The energy sector has a large and growing percentage of their entirety of patenting activity dedicated to green research.

3. Energy firms allocate significantly more of their innovation efforts toward green innovation than other firms active in the green patenting space.
   - Significantly more than highly rated ESG firms.
   - Significantly more than other sectors that are in aggregate large green patent producers.
     - Nearly three times the relative focus on green innovation in their innovation portfolio as the average industry, at 22.25% of patenting.
     - **Net-Green Patenting (Patent class has one green option)**

Findings

4. The green patents of energy producing firms are significantly higher quality:
   - In terms of being more highly cited.
   - More likely to produce "blockbuster" green patents than other firms.

5. The patents of energy producing firms also differ with respect to other attributes:

- **First mover:** Energy patents are among the first patents in each green innovation classes.
- Specifically, within a given subclass of green technologies, earlier patent are predominantly grants to energy firms.
- **Influential early patents:** The patents that are granted to energy firms tend to receive higher citations compared to green patents granted to non-energy firm amongst all first movers.
- **Non-Substitutability of Energy Industry's *Brown* Patents:** Brown patents of energy firms show more relative importance for the entirety of the green innovation landscape than the brown patents of non-energy firms.

6. Moreover, we do not find evidence that energy companies are restricting others from innovating in specific product areas (**no evidence of patent thickets**).
   - Traditional energy firms' green patents are predominantly cited by firms *outside* of the energy industry (74% of citations) – comparatively more outside influence than other green patentors (71%).

Findings

7. In investigating whether energy firms simply purchase or acquire these innovative patents from outside firms and innovators, we find that the vast majority (over 97%) of their green patents are initiated and developed in-house (organically).

- Further, traditional energy firms even appear over-represented amongst the top net green patenting firms in the economy.
- Energy firms are significant global producers of alternative energy (electricity wattage) tied to their blockbuster patents and are central investors in some of the largest renewable projects worldwide (demonstrated by Shell's involvement in NoordzeeWind, the first wind farm with capacity to generate over 100MW, built in the Dutch North Sea).

8. On the intensive margin, energy firms even get less "credit" in terms of **incremental ESG score increase** for each (higher quality) green patent they produce.

9. These energy firms are **explicitly excluded** from many ESG funds, and the targets of many divestiture campaigns whose stated aims often include push forward green energy innovation.

Green Funds Investment in Energy Sector

Conditional on a firm being in the Energy Sector

VARIABLES	(1) %fund holding	(2) I[%fund holding > 0]	(3) I[%fund holding > %index]
Green Fund	-0.0706***	-0.0454***	-0.0131***
	(-9.250)	(-10.149)	(-3.973)
Log MVE	0.0947***	0.0372***	0.0103***
	(80.438)	(75.525)	(32.136)
Log Age	0.0238***	0.0071***	0.0027***
	(24.113)	(10.186)	(5.396)
Cash	0.0901***	0.0283***	0.0771***
	(6.345)	(3.857)	(14.169)
Book Leverage	-0.3754***	-0.0238***	0.0734***
	(-29.694)	(-3.995)	(17.241)
Investment	0.1016***	0.1083***	0.1236***
	(5.586)	(11.693)	(18.582)
Lag Return	0.0102***	0.0207***	0.0170***
	(5.132)	(17.746)	(17.622)
Observations	4,559,019	4,559,019	4,559,019
R-squared	0.050	0.031	0.006
Year-Quarter FE	YES	YES	YES

Energy firms are:

1. **significantly less likely to be held at all;**
2. **are held in significantly smaller amounts;**
3. **are held in significantly smaller weights relative to their index-weight; by *Green Funds* vs. all other funds.**

Green Funds Investment in Energy Sector

Conditional on a firm being in the Top 3 Sectors (outside of Energy)

VARIABLES	(1) %fund holding	(2) I [%fund holding > 0]	(3) I [%fund holding > %index]
Green Fund	0.0282***	0.0219***	0.0321***
	(19.655)	(22.249)	(38.162)
Log MVE	0.0683***	0.0343***	0.0146***
	(238.610)	(264.053)	(165.541)
Log Age	-0.0034***	0.0039***	0.0012***
	(-16.931)	(24.814)	(10.259)
Cash	0.0787***	0.0428***	0.0314***
	(85.773)	(71.144)	(70.380)
Book Leverage	-0.0223***	-0.0020***	-0.0032***
	(-35.589)	(-4.366)	(-9.184)
Investment	0.0848***	0.0203***	-0.0043
	(15.236)	(5.523)	(-1.629)
Lag Return	0.0476***	0.0287***	0.0197***
	(144.284)	(136.294)	(111.318)
Observations	105,609,003	105,609,003	105,609,003
R-squared	0.036	0.021	0.008
Year-Quarter FE	YES	YES	YES

Top 3 Sectors (outside of Energy):

1. significantly more likely to be held at all;
2. are held in significantly larger amounts;
3. are held in significantly larger weights relative to their index-weight; by *Green Funds* vs. all other funds.

Real Activities:
Leaving Green Patents Strategically Unused on the Shelf?

	(1)	(2)	(5)	(6)
	Has Low Carbon Products		Has CAPEX in Green Products and Services	
	All	Energy Sector	All	Energy Sector
Green Patent/ All Patent	0.4431***	0.6905***	0.1352***	0.3692***
	(5.847)	(3.757)	(6.725)	(3.091)
Log MVE	0.0360***	0.0453***	0.0019***	0.0151***
	(23.473)	(7.194)	(4.721)	(3.680)
Log Age	0.0197***	0.0240	0.0016	0.0085
	(5.240)	(1.591)	(1.563)	(0.868)
Cash	0.0005	-0.0437	-0.0000	-0.0404
	(0.281)	(-0.515)	(-0.085)	(-0.733)
Book Leverage	-0.0037	0.0074	0.0005	0.0030
	(-0.538)	(0.138)	(0.294)	(0.085)
Investment	0.0160	-0.1199	0.0070	-0.0598
	(0.404)	(-1.247)	(0.667)	(-0.956)
Constant	-0.2277***	-0.2640***	-0.0141***	-0.0853**
	(-18.249)	(-4.545)	(-4.253)	(-2.259)
Observations	4,465	429	4,465	429
R-squared	0.147	0.203	0.018	0.084

Green patenting activities are followed by:

- Having more low carbon products
- Having more CAPEX in green products and services

Takeaways

1. Firms that are restricted by mandates and campaigns seem to contribute significantly to solve the problem ESG investments are trying to solve.

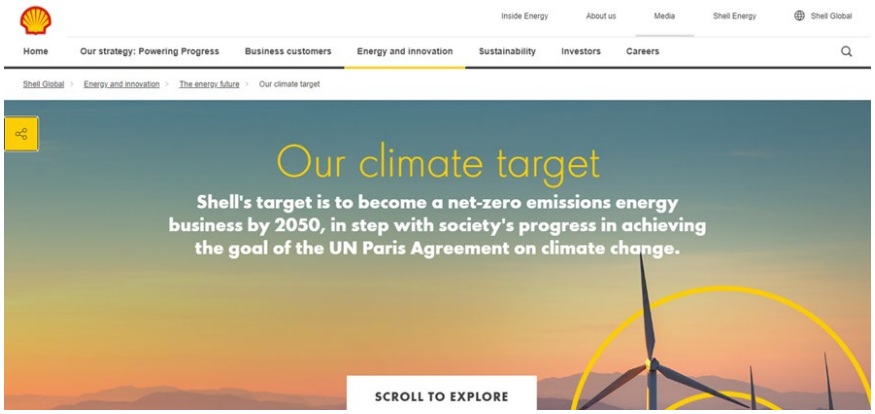
2. ESG Scores by and large **do not reward** for green patenting activity.

3. There is still work to be done as to whether capital allocation indeed follows the ESG scores, and to what extent this ESG score-motivated investment can be calibrated to achieve better capital allocation by the investors.

- Moreover, our findings raise important questions as to whether the current exclusions of many ESG-focused policies – along with the increasing incidence of explicit divestiture campaigns - are optimal, or whether reward-based incentives would lead to more efficient innovative outcomes.

Next Steps →

- Continue to explore further measures of "real activity" of these energy firms.
- Do more textual analysis to tie 10-k and other firm information releases to actual investments. E.g.,



- We have collected data on global investment in green bonds, both private and public sector
  - Use this data – along with data from Mergent FISD - to explore amounts and costs of capital of firms

Elliot Berman (center, in patterned tie) and his team at Solar Power Corp. pose outside their office and manufacturing facility in Braintree, Mass., in 1973. John Perlin, author of *Let It Shine: The 6,000-Year Story of Solar Energy,* credits Berman, Solar Power Corp. and Exxon with "planting the flag of photovoltaics throughout the world."

Robert Willis/Solar Power Corp. via John Perlin