

Induced Innovation and International Technological Opportunity in the Field of Energy

Evidence from World Patent Citations

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Introduction:

Determinants of innovation process

- Identification and estimation of the two main determinants of innovation:
 - *Demand pull* (induced innovation / market price)
 - *Technology push* (national and international technological opportunity)

For eleven energy saving technologies in five countries:

- France, Germany, Japan, UK and the US

Presentation Overview

- ① Energy Innovation
- ② Main determinants of innovation process :
 - A) Energy price
 - B) Technological opportunity
- ③ Models & Estimations
- ④ Conclusions

1 Energy Innovations

Energy technologies have been previously defined by:

- Popp (1998, 2002),
- Johnstone & al. (2007),
- Definitions set up by Minister of the economy (France)

Two main energy innovation groups:

New products technologies

- Biomass
- Fuel cells
- Geothermal
- Hydrogen
- Solar energy
- Tide & Wave
- Wind

New process technologies

- Heat exchange
- Heat pump
- Stirling engines
- Waste heat recovery

1 Energy Innovations

- Innovations are measured by patent application
- Possibility to indentify distinct “energy innovation group” according to the WIPO IPC (scheme over 60.000 technology classification)
- We retain only the first patent application, thus the date of this application is the priority date and it is the closest to the innovation date.
- We assign each patent to the country of residence of the inventor.
- Innovations are approximated by the percentage of patent applications per year and per technology group

1 Energy Innovations

- Patent data are taken from the EPO Worldwide Patent Statistical Database : **PATSTAT**

- 80 patent offices
- 75 millions of entries
- Patent Applications
- Patent Publications
- Patent Citations data

Patents by Innovating Technology, 1979-2003

Technology	Number of Patents	Percentage
Biomass	14 223	4.53%
Fuel Cell	58 792	18.70%
Geothermal	4 424	1.41%
Heat exchange	109 771	34.92%
Heat pump	9 894	3.15%
Hydrogen	33 497	10.66%
Solar	41 058	13.06%
Stirling Engines	8 105	2.58%
Tide & Wave	5 619	1.79%
Waste Heat Recovery	13 112	4.17%
Wind	15 822	5.03%
Total	314 317	100%



(11) EP 2 065 944 A1

(12) DEMANDE DE BREVET EUROPEEN

(43) Date de publication:
03.06.2009 Bulletin 2009/23

(51) Int. Cl.:
H01L 31/048 (2006.01)
E04D 13/18 (2006.01)

(21) Numéro de dépôt: 08300284.0

(22) Date de dépôt: 27.11.2008

(84) Etats contractants désignés:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT
RO SE SI SK TR
Etats d'extension désignés:
AL BA MK RS

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(30) Priorité: 27.11.2007 FR 0759348
(71) Demandeur: Graphisol (Société à Responsabilité
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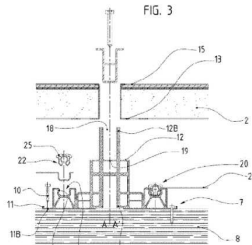
Prior application

(54) Dispositif support de panneaux de couverture de toiture

(57) La présente invention concerne un dispositif (1) support d'au moins un panneau (2) de couverture de toiture et une telle toiture. Ce dispositif (1) est constitué d'au moins un rail (3) pourvu en partie haute (4) de moyens (5) supportant dudit panneau (2) et en partie basse (6) de moyens (7) de fixation à au moins un élément (8) de ladite toiture, ledit rail (3) comprenant encore des moyens (20) de blocage d'un film (21) de protection de ladite toi-

ture, lesdits moyens de blocage (20) se situant supérieurement auxdits moyens de fixation (7) de sorte que ces derniers soient couverts par ledit film (21), caractérisé par le fait que lesdits moyens de blocage (20) comprennent au moins une partie mâle (22) de forme complémentaire avec au moins une partie femelle (23) de manière à coopérer par emboîtement, bloquant une extrémité dudit film (21).

FIG. 3



Printed by Jouve, 75001 PARIS (FR)

EP 2 065 944 A1

(19) RÉPUBLIQUE FRANÇAISE
INSTITUT NATIONAL
DE LA PROPRIÉTÉ INDUSTRIELLE
PARIS

(11) N° de publication : 2 924 141

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(21) N° d'enregistrement national : 07 59348

(51) Int. Cl.: E 04 D 13/18 (2006.01), H 01 L 31/042

(12) DEMANDE DE BREVET D'INVENTION A1

(22) Date de dépôt : 27.11.07.

(30) Priorité :

(71) Demandeur(s) : QUALITELEC Société à responsabilité
limitée — FR.

(72) Inventeur(s) : CANET PATRICE et DELPEYROU
JOSE.

(73) Titulaire(s) :

(74) Mandataire(s) : CABINET BREVSUD.

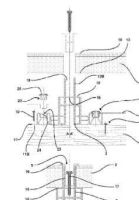
(43) Date de mise à la disposition du public de la
demande : 23.05.09 Bulletin 09/22.

(46) Liste des documents cités dans le rapport de
recherche préliminaire : Se reporter à la fin du
présent fascicule

(47) Références à d'autres documents nationaux
apparentés :

(54) DISPOSITIF SUPPORT DE PANNEAU DE COUVERTURE DE TOITURE.

(57) La présente invention concerne un dispositif (1) support d'au moins un panneau (2) de couverture de toiture et une telle toiture. Ce dispositif (1) est constitué d'au moins un rail (3) pourvu en partie haute (4) de moyens (5) supportant dudit panneau (2) et en partie basse (6) de moyens (7) de fixation à au moins un élément (8) de ladite toiture, caractérisé par le fait que ledit rail (3) comprend des moyens (20) de blocage d'un film (21) de protection de ladite toiture.



FR 2 924 141 - A1



Presentation Overview

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2.A Induced Technological Change



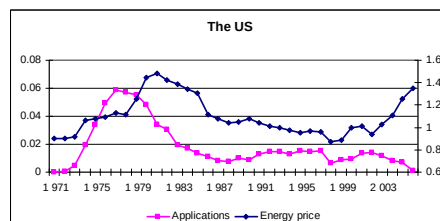
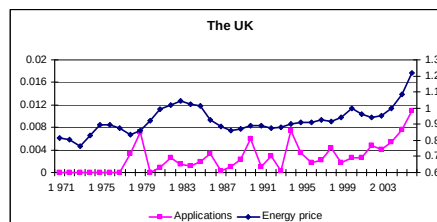
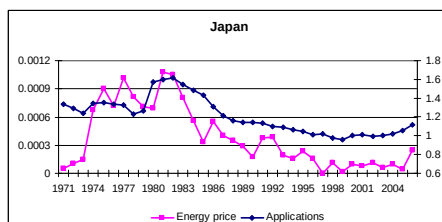
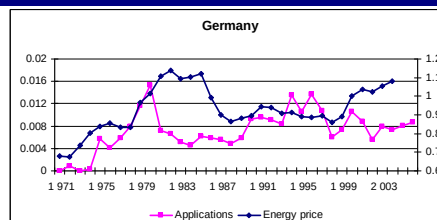
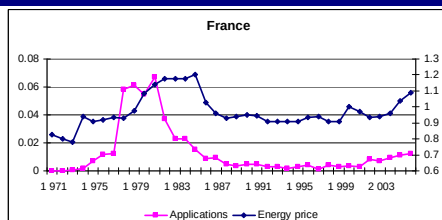
“A change in the relative prices of the factors of production is itself a spur to innovation, and to invention of a particular kind directed to economizing the use of a factor which has become relatively expensive”

Sir John Hicks, 1932

Energy prices represent the market demand for innovation

2.A Induced Technological Change

Product technology : Solar



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2.B Knowledge Stock : Overview

① R&D expenditures are not available at technology level.

② Knowledge Stocks are estimated with patent citation.

Methodology :

- Caballero et Jaffe (1993), Jaffe and Trajtenberg(1996), Hall and al. (2001)
- Popp (2002) for its application to energy field (US)
- Jaffe and Trajtenberg (1998) for their extension to international knowledge spillovers

③ Patent Data on citation are taken from PATSTAT

2.B Knowledge Stock : Patent Citation

We assume that knowledge flow is proxied by patent citations:

- Jaffe, Trajtenberg and Fogarty (2000). The authors surveyed US inventors of cited and citing patents, and show that USPTO patent citations could be considered as a signal for spillovers.
- Duguet & Mac Garvie (2005). Assess the relevance of EPO patent citations as proxies of knowledge flows by exploring the correlation between citation patterns and the answers to the Community Innovation Survey (CIS) questionnaire by a sample of French firms.
- MacGarvie (2006). Use EPO citations to measure the impact of foreign knowledge on French firms and control the validity of EPO citations by using same sample of USPTO citations that replicates the regressions. The findings are quite similar to those obtained with EPO citation data.

2.B Knowledge Stock : Patent Citation

- ① When a patent is granted, it contains several citations to earlier patents that are related to the current invention
- ② Patent receiving many citations embodies useful knowledge and provides many technological opportunities. α
- ③ Patent productivity depends on the frequency of citations received.
 $\alpha(\text{citations})$
- ④ Indicator created, is built on patent flows weighted by their subjective productivities.
 $N \times \alpha$
- ⑤ Popp (2002) shows that it is necessary to take into account changes in the productivities of the knowledge available to the inventor.

2.B Knowledge Stock : Patent Citation

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12 N° d'enregistrement national : **07 59348**

13 Int. Cl.⁸ : **E 04 D 13/18 (2006.01), H 01 L 31/042**

14 **DEMANDE DE BREVET D'INVENTION A1**

15 Date de dépôt : 27.11.07.
16 Priorité :

17 Date de mise à la disposition du public de la
demande : 29.05.09 Bulletin 0922.

18 Liste des documents cités dans le rapport de
recherche préliminaire : Se reporter à la fin du
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20 Demandeur(s) : QUALITELEC Société à responsabilité
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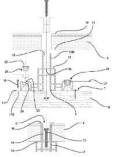
21 Inventeur(s) : CANET PATRICE et DELPEYROU
JOSE

22 Titulaire(s) :

23 Mandataire(s) : CABINET BREVISUD.

24 **DISPOSITIF SUPPORT DE PANNEAU DE COUVERTURE DE TOITURE.**

25 La présente invention concerne un dispositif (1) sup-
port d'un miroir et d'un panneau (2) de couverture de toiture et
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dudit panneau (2) et d'un panneau (3) de moyens (7) de
fixation à au moins un élément (8) de toiture, caracté-
risé par le fait que ledit (3) comprend des moyens (10)
de blocage d'un film (21) de protection de ladite toiture.

26 

27 (10) 日本国特許庁 (J.P.) (12) 公開特許公報 (A) (11) 特許出願公開番号
特開平10-219950
(43) 公開日 平成10年(1998) 8月18日

28 (51) Int. Cl.⁸ E 04 D 13/18 H 01 L 31/042

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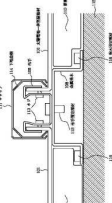
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33 (74) 代理人 弁護士 丸島 慎一 最終頁に続く

34 【発明の名称】 屋根材及びその施工方法

35 【要約】
【課題】 設置施工が容易で、外観と電気的安全性に優れた
屋根材を提供する。
【解決手段】 本発明の屋根材は、太陽電池素子と金属
補強材を持つ太陽電池-一体型屋根材が、屋根に固定され
てなる屋根材であり、太陽電池-一体型屋根材の下部に金
属部材を設け、あるいは、傾り合う太陽電池-一体型屋根
材が隣接部に沿って金属部材を設け、該金属部材と、複
数の太陽電池-一体型屋根材の金属補強材とが電気的に導
通され、かつ金属部材が電気的に接地されていることを
特徴とする屋根材である。

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2.B Knowledge Stock : Construction

- The indicator is based on the formation of the knowledge stock modeled by Caballero and Jaffe (1993).

The knowledge stock available for an inventor located in country **c** at date **T** in function of its origin **d** (domestic or foreign):

$$Know(T, c, d, i) = \sum_{t=0}^{T-1} \alpha(t, c, d, i) \cdot N(t, d, i) \cdot e^{-\beta_{1,d}(T-t)} \cdot (1 - e^{-\beta_{2,d}(T-t)})$$

- Knowledge flows are proxied by the number of patents **N(t,d,i)**, granted in year **t** in country **d** (national and international)
- weighted by their productivity **α(t,c,d,i)**.
- Knowledge flows are affected by two opposing forces: obsolescence **β1,d** and diffusion **β2,d**.

2.B Knowledge Stock : Construction

Patent productivities are estimated with the well know « citation function » detailed by Hall and al. (2001).

The citation function estimated is :

$$P_{cit}(ctd, ctg, i, c, d) = \alpha(ctd, c, d, i) \cdot \alpha(ctg, c, i) \cdot \exp[-\beta_{1,d}(ctg - ctd)] \cdot (1 - \exp[-\beta_{2,c}(ctg - ctd)])$$

P_{cit} is the probability that a patent cohort applied in year **ctg** in country **c** cites another cohort granted in year **ctd** in country **d**.

It is the ratio of the number of citations **C_{T,L,t,i}** to the product of the potential number of cited patent **N_{t,i}** and citing patent **N_{T,L}**.

$$P_{cit}(ctd, ctg, i, c, d) = \frac{Cit(ctd, ctg, i, c, d)}{N(ctd, d, i) \cdot N(ctg, c, i)}$$

α(ctg,c,i) is the frequency by which patents applied in citing year **ctg** cite earlier patents

2.B Knowledge Stock : Construction

- We estimate it for the 5 countries **c** (France, Germany, Japan, UK and the US) and for the 11 technological fields.
- For each origin **d** (domestic and foreign) and technology field **i** (1,...,11), we estimate:

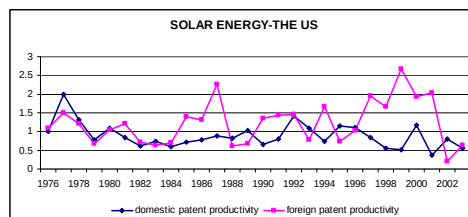
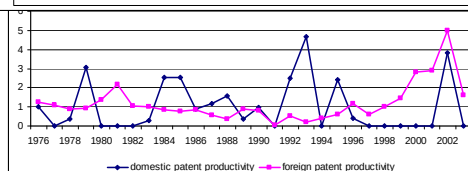
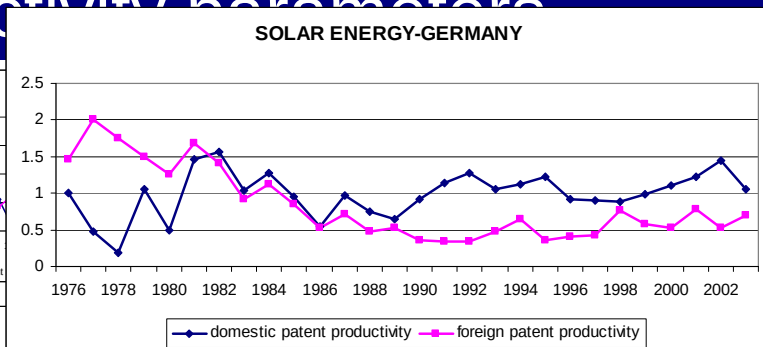
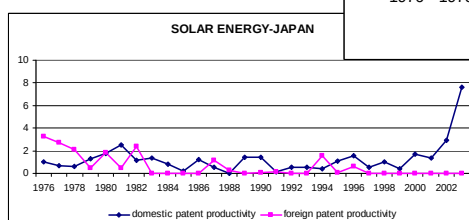
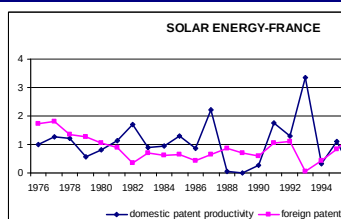
$$P_{cit}(ctd, ctg, i, c, d) = \alpha(ctd, c, d, i) \cdot \alpha(ctg, c, i) \cdot \exp[-\beta_{1,d}(ctg - ctd)] \cdot (1 - \exp[-\beta_{2,d}(ctg - ctd)])$$

- **ctg=1977,...,2008**
- **ctd=1976,...,2003**
- **d=c,-c**

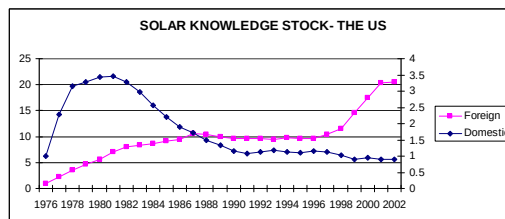
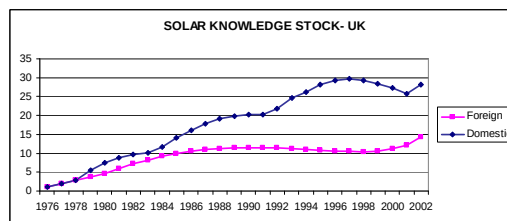
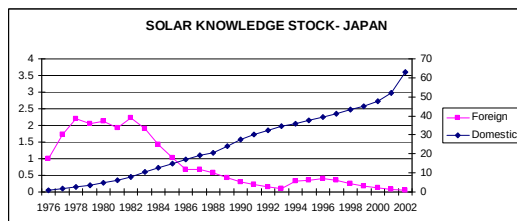
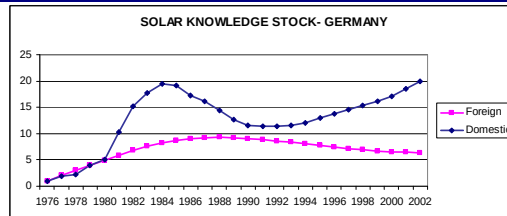
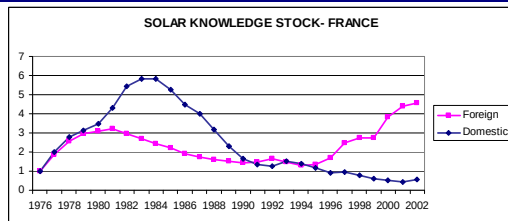
To overcome identification problems:

- we normalize $\alpha(ctg, c, i) = 1$ for **ctg=1977-79** and $\alpha(ctd, c, d, i) = 1$ for **ctd=1976** and **d=c**
- $\alpha(ctg, c, i)$ is grouped in four-year intervals

2.B Knowledge Stock : Productivity parameters



2.B Knowledge Stock : knowledge stock



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3 Estimated Models

The model to estimate is:

$$\text{Log}\left(\frac{\text{Patent}(t, c, i)}{\text{TPatent}(t, c)}\right) = \text{cst} + \beta_1 \cdot \text{Log} \cdot P(t-1, c) + \beta_2 \cdot \text{Log} \cdot \text{Know}(t, c, c, i) + \beta_3 \text{Log} \cdot \text{Know}(t, c, -c, i) \\ + \beta_4 \text{Log} \cdot \text{Policies}(t, c) + \varepsilon_{t,c,i}$$

- $i = 1, \dots, 11$ indexes technologies
- $c = 1, \dots, 5$ indexes countries
- $t = 1980, \dots, 2003$ indexes time

3 Results

Independant variables	All technologies		Product technologies		Process technologies	
	Estimates	S.E.	Estimates	S.E.	Estimates	S.E.
Lagged Energy Price	0.974	0.308 **	1.348	0.421 **	0.975	0.496 *
Domestic Know Stock	0.390	0.049 **	0.338	0.062 **	0.312	0.098 **
Foreign Know Stock	0.451	0.041 **	0.416	0.058 **	0.533	0.068 **
Policies	0.092	0.068	0.142	0.075 *		
Number of observations	982		623		373	
Number of technologies	11		7		4	
Number of countries	5		5		5	
Est-per	1980-2003		1980-2003		1980-2003	
R-squared	0.75		0.70		0.81	

Notes: * and ** refer to 5%, and 1% level of statistical significance.

Conclusions

- Environmental taxes will not only reduce pollution through a change of agent behaviours but also through technological change.
- These innovations are only possible by the presence of technological opportunities
- Similarly technological opportunities are not enough. There must be some mechanisms that encourage innovations.
- Knowledge spillovers are very important in energy field, meaning that a research performing in one country is going to generate high externalities to other countries.

Thank you