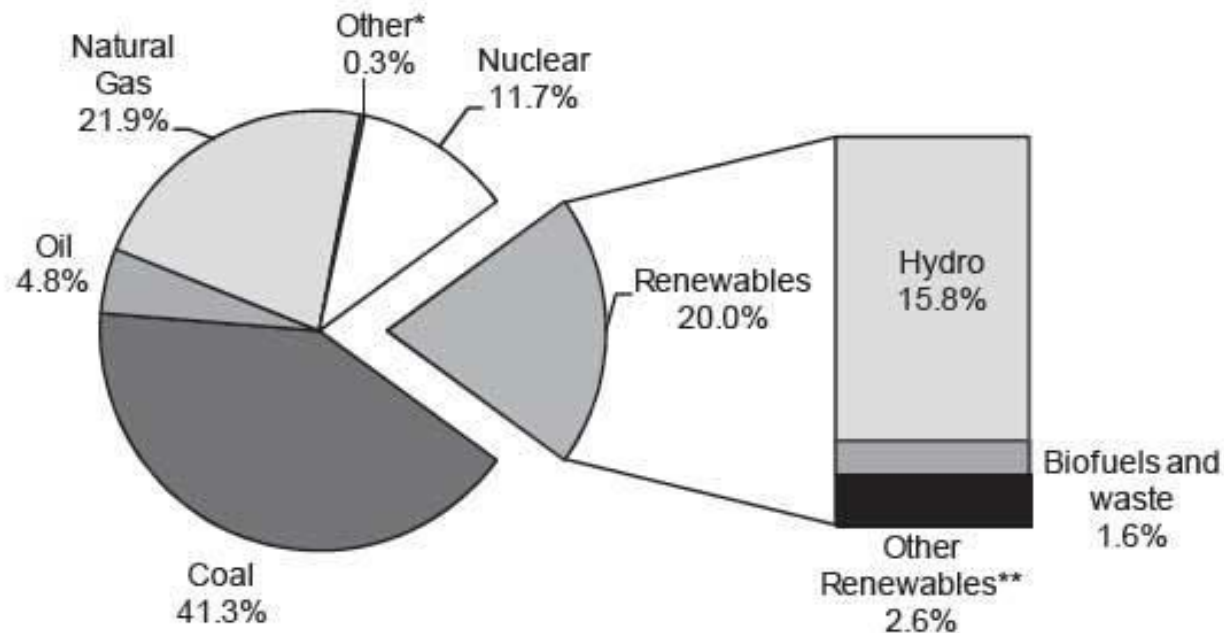


Cambiamento tecnologico e Ambiente

Francesco Nicolli

Un caso studio – Il settore energia e gli incentivi alle rinnovabili

Figure 7: Fuel shares in world electricity production in 2011



* Other includes electricity from energy sources not defined above such as non-renewable wastes, peat, and chemical heat

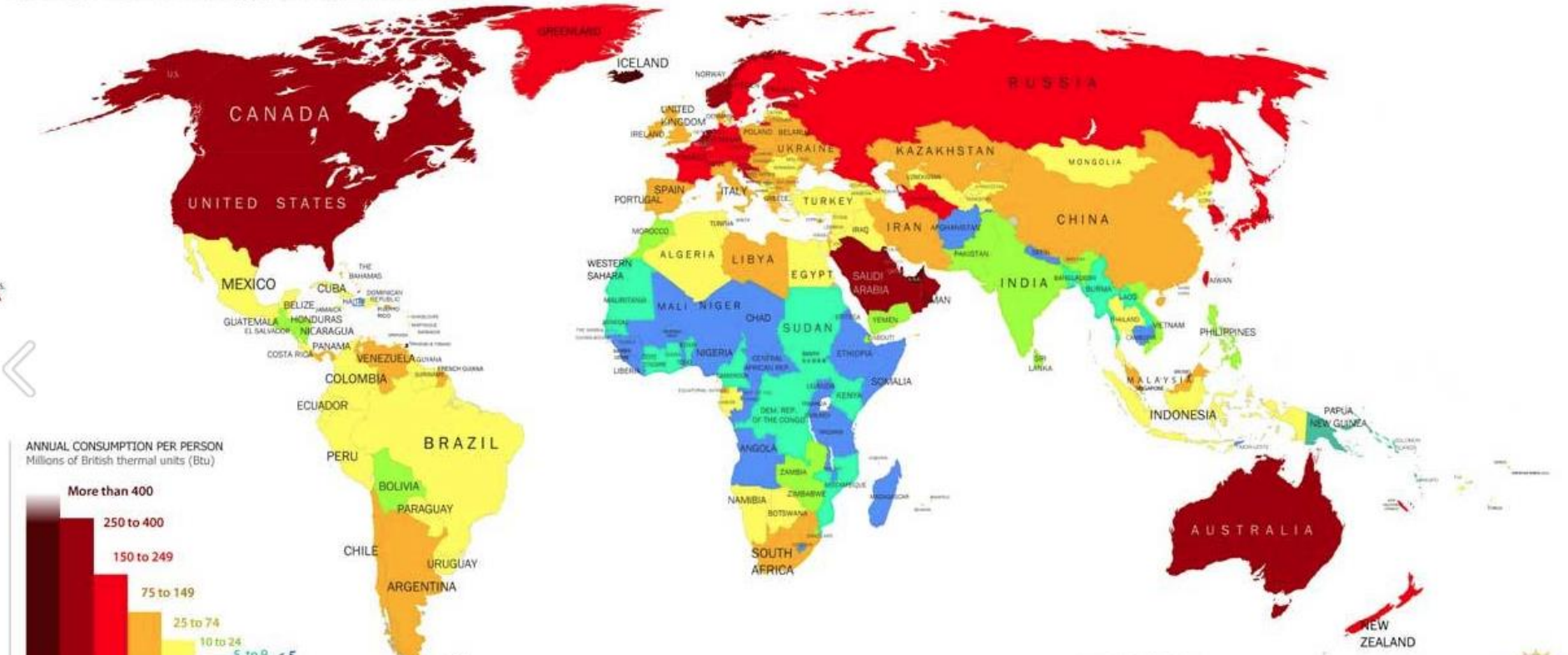
** Other renewables includes geothermal, wind, solar, tide

Note: Totals in graphs might not add up due to rounding.

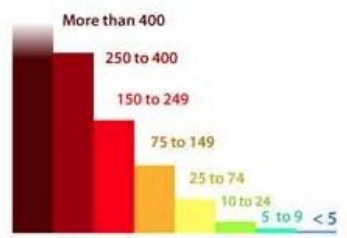
Source: IEA

Energy Consumption Per Person, by country, 2010.

SOURCES: U.S. Energy Information Administration, International Energy Agency, CIA World Factbook, U.N. Dept. of Economic and Social Affairs



ANNUAL CONSUMPTION PER PERSON
Millions of British thermal units (Btu)



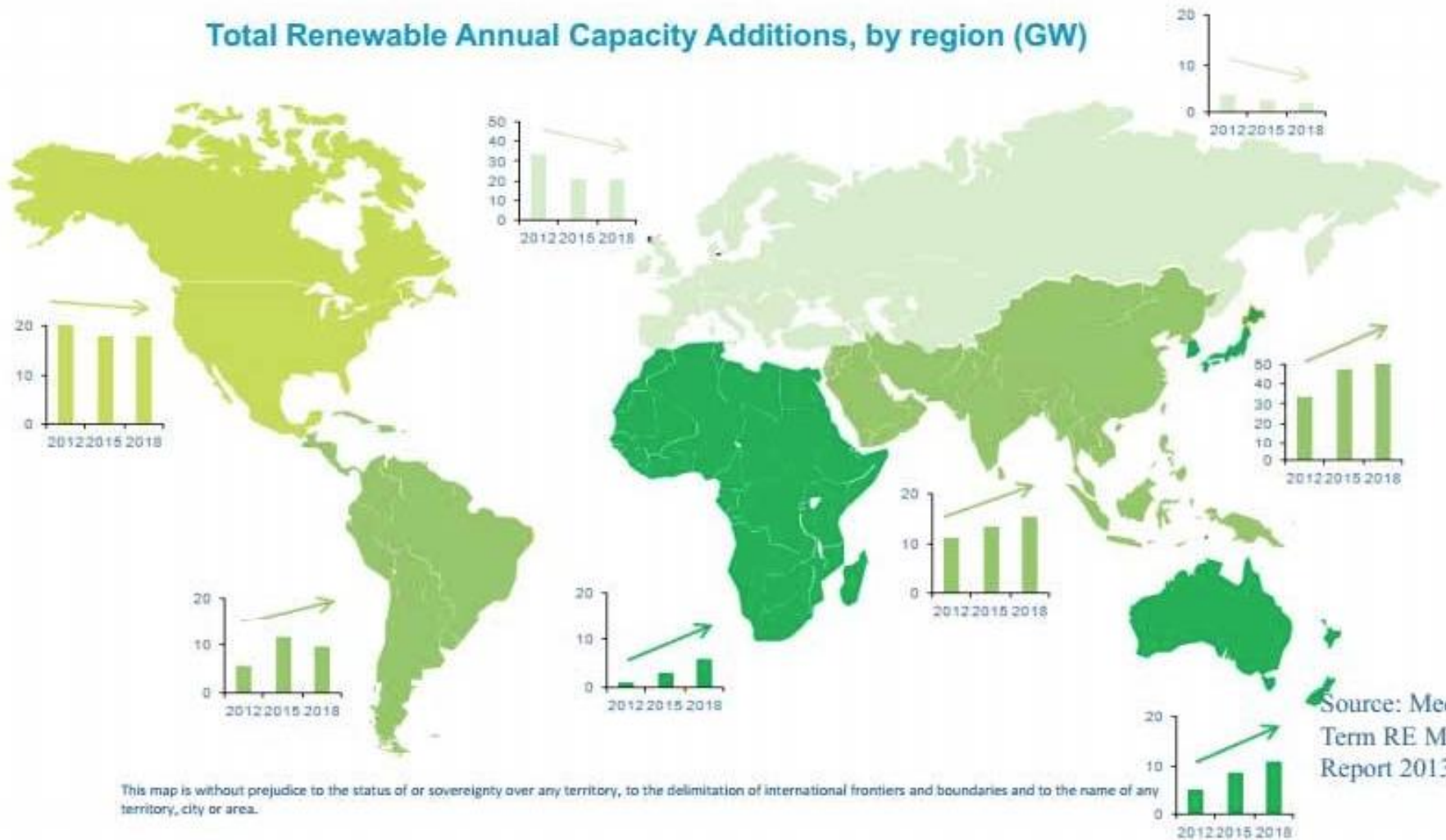
1 million Btu = roughly 8 gallons of gasoline

BURN
an energy journal

A public radio project from SoundVision Productions
Anrica Deb. contributing digital producer



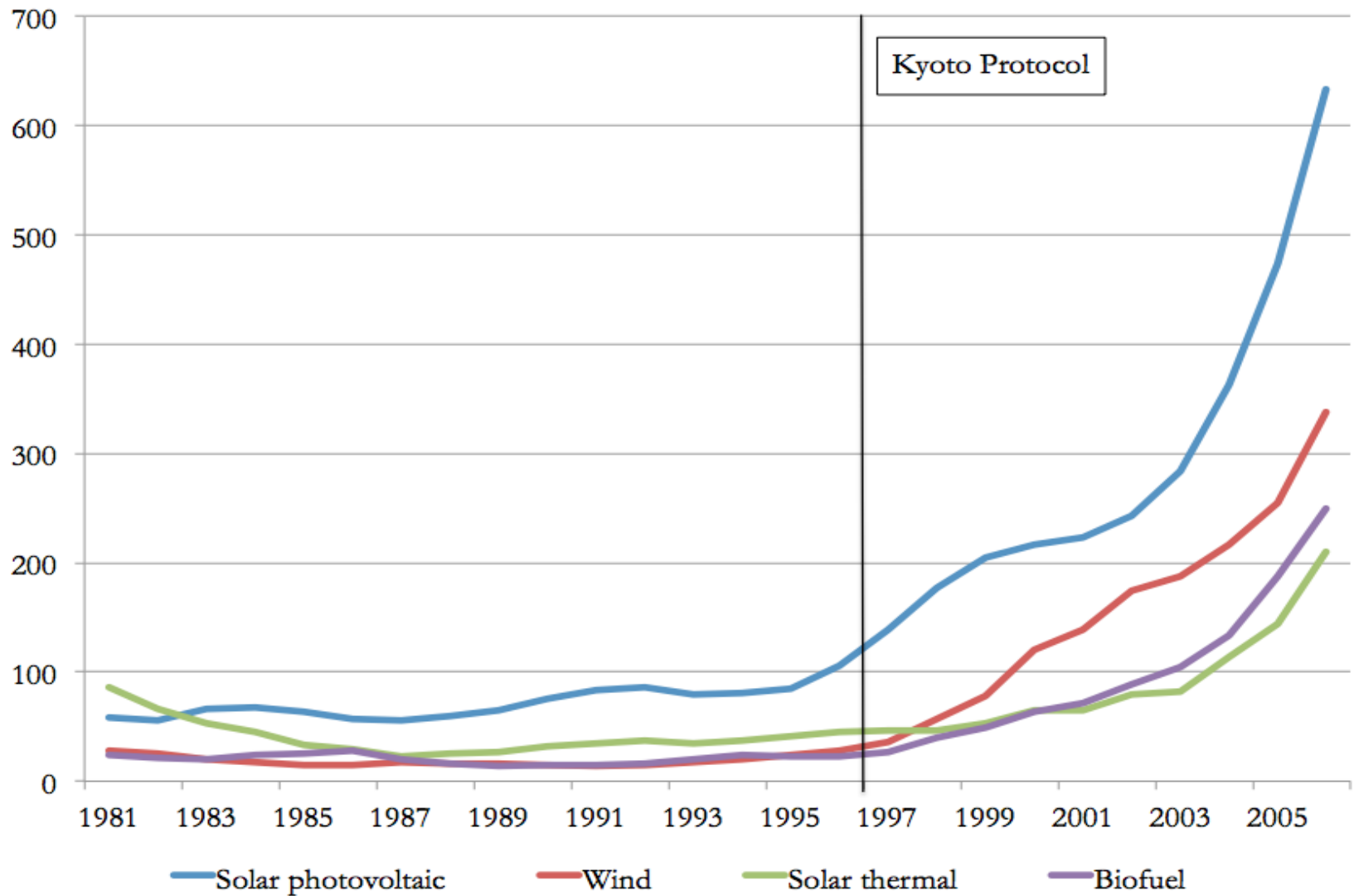
Total Renewable Annual Capacity Additions, by region (GW)



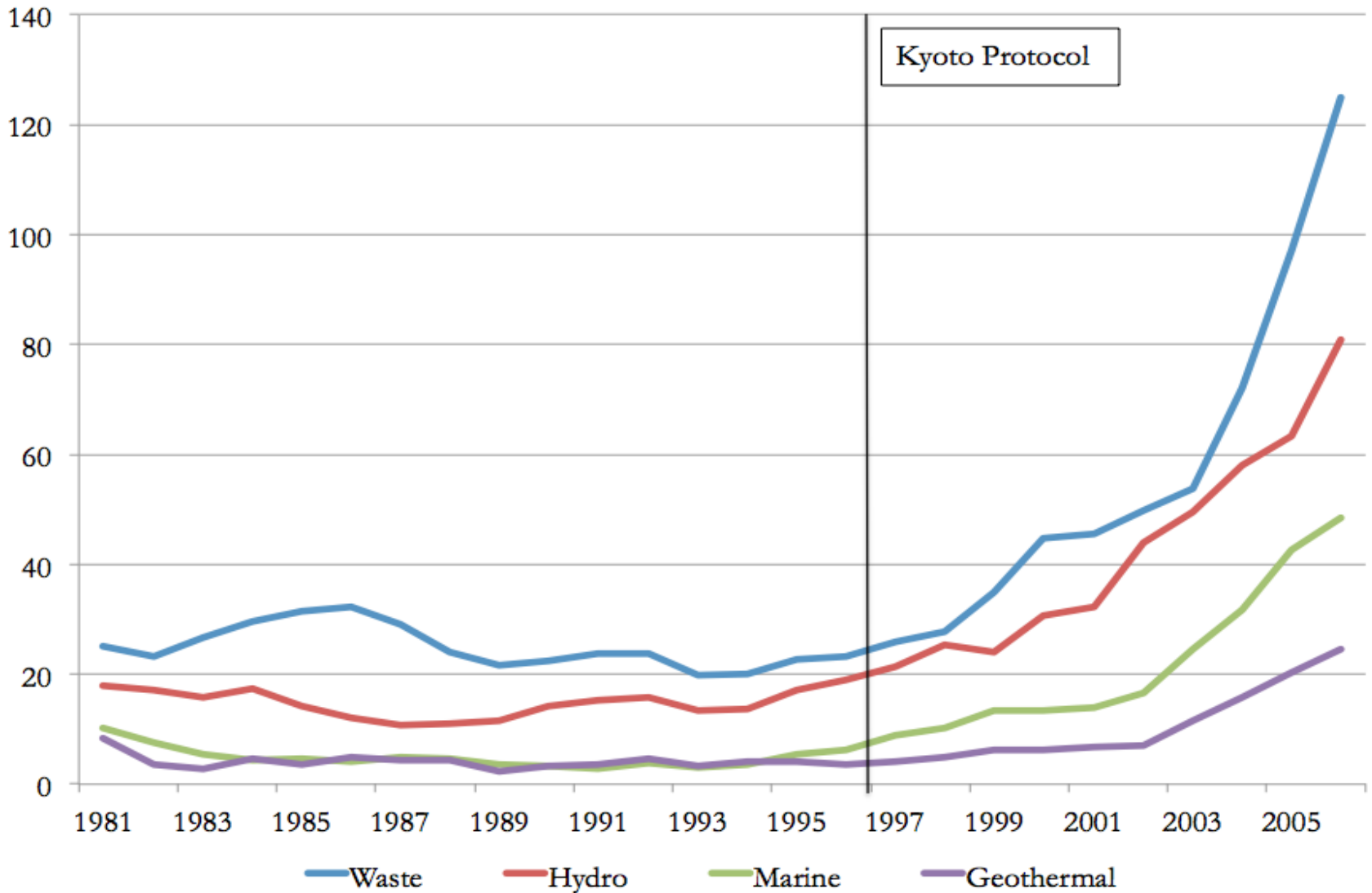
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

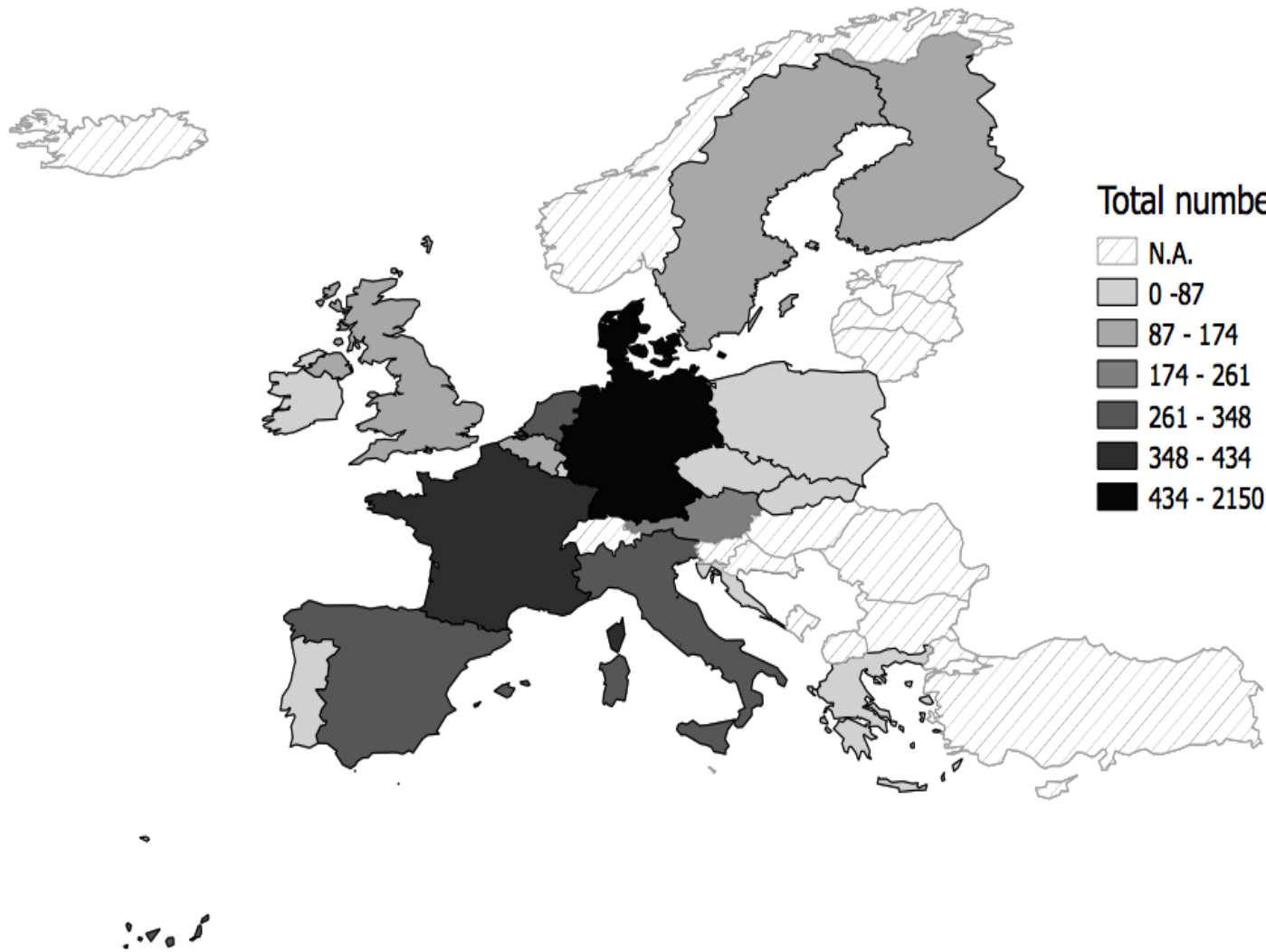
Source: Medium Term RE Market Report 2013

Patent Trends



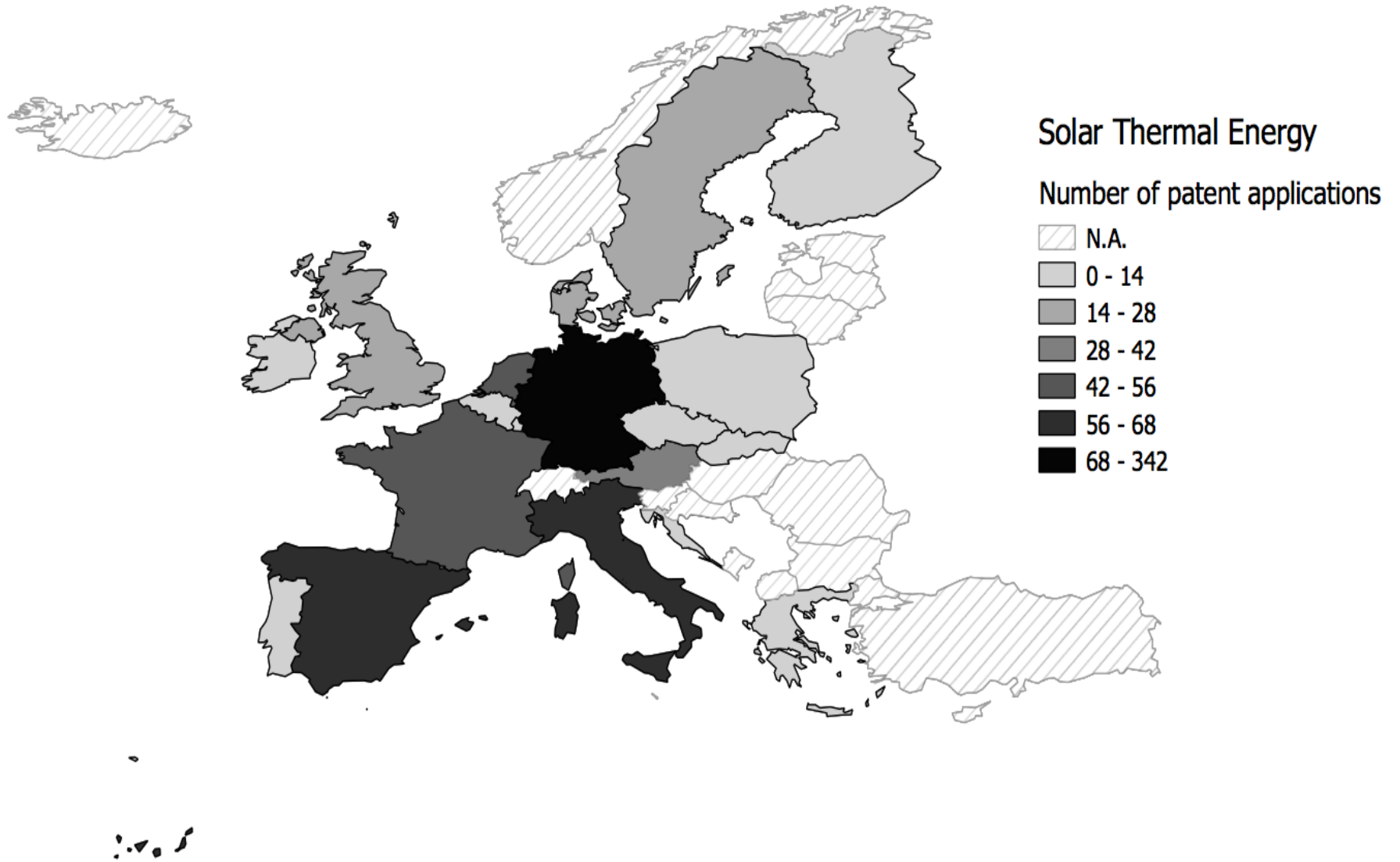
Patent Trends

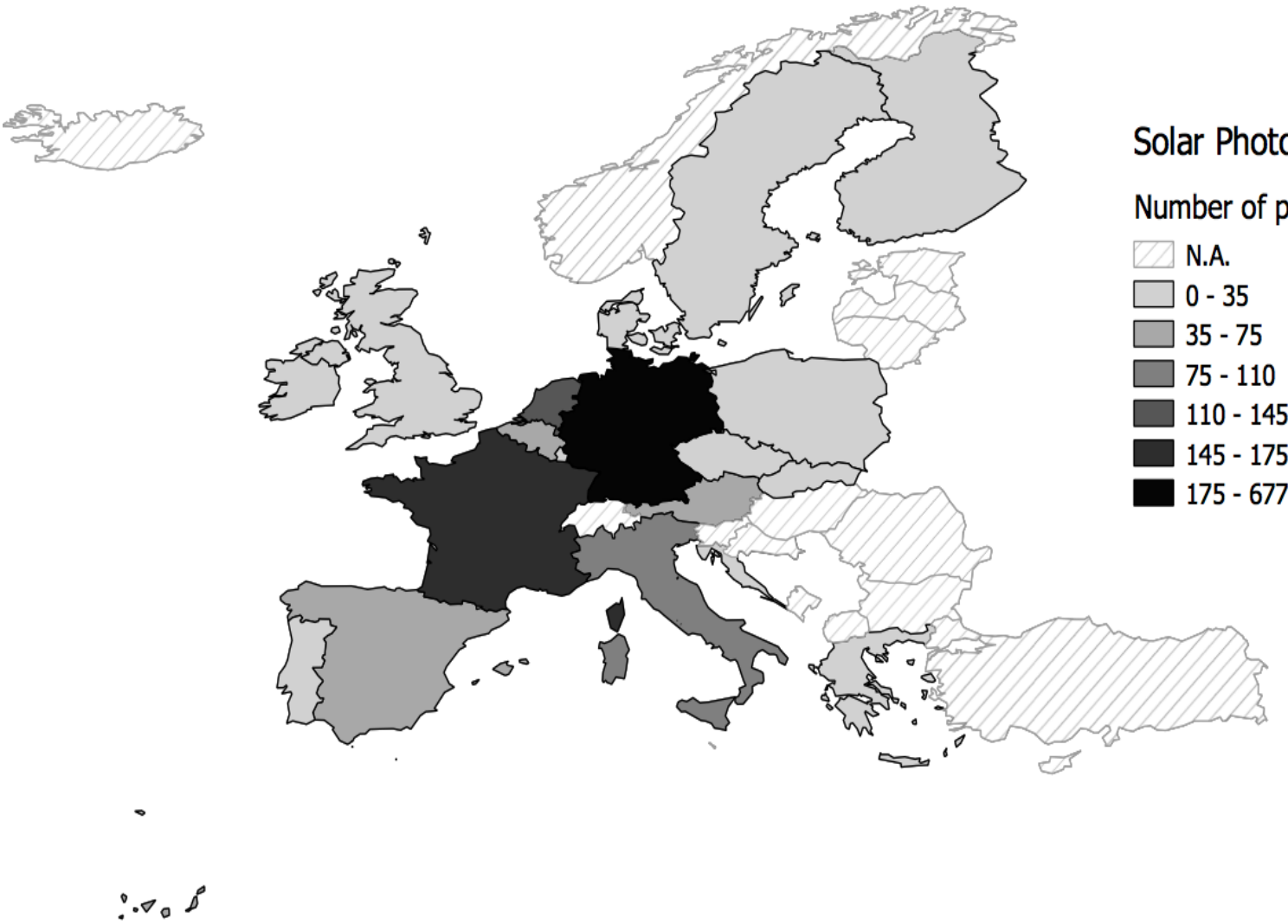




Total number of patent applications

- N.A.
- 0 - 87
- 87 - 174
- 174 - 261
- 261 - 348
- 348 - 434
- 434 - 2150





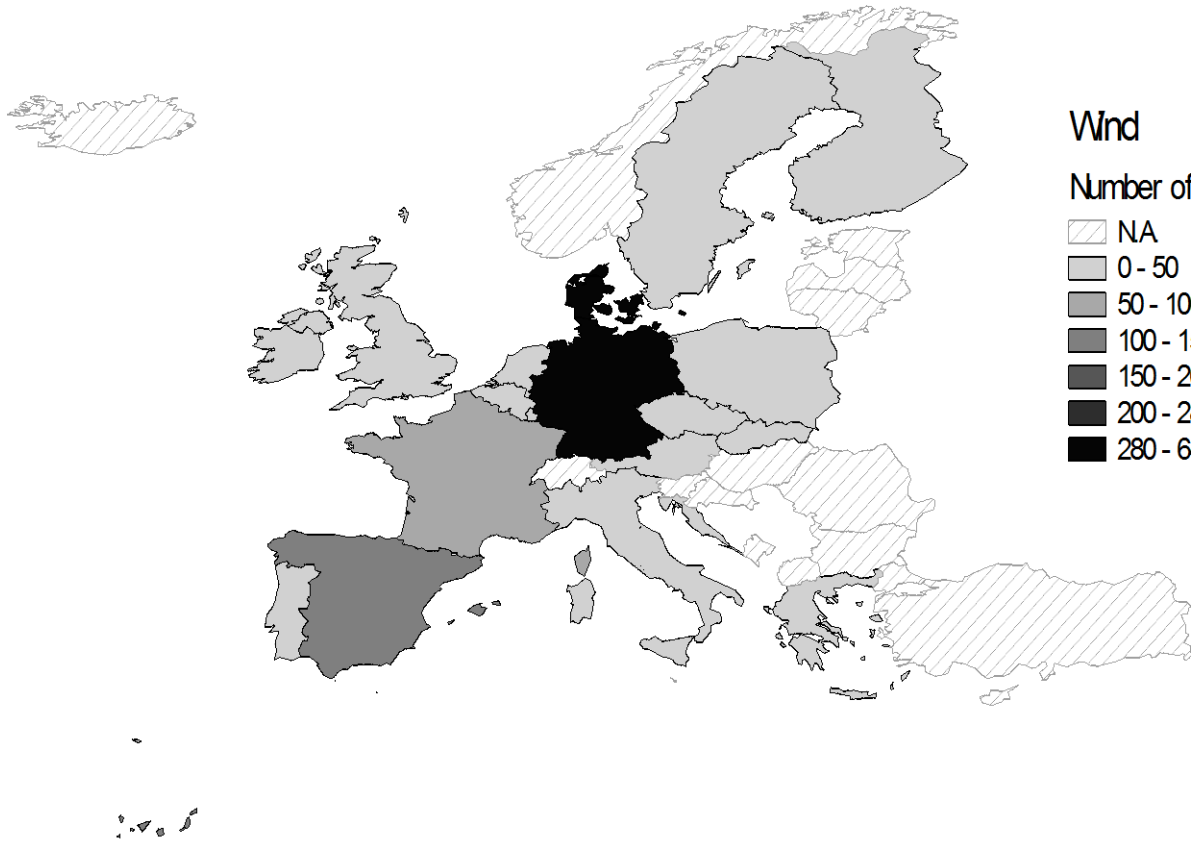
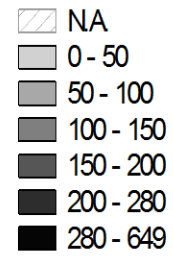
Solar Photovoltaic (PV) Energy

Number of patent applications

- N.A.
- 0 - 35
- 35 - 75
- 75 - 110
- 110 - 145
- 145 - 175
- 175 - 677

Wind

Number of patent applications



Determinanti

- Politiche
- Grado liberalizzazioni mercato
- Consumo energia (size del mercato)
- Prezzi energia

Politiche

- Negli ultimi 40 anni si è assistito ad un proliferare di politiche pubbliche a sostegno delle rinnovabili. Esse avevano prevalentemente 4 scopi:
 1. Ridurre l'incertezza degli investimenti in rinnovabili
 2. Aumentare il mercato delle rinnovabili rendendole relativamente più convenienti rispetto alle alternative tradizionali
 3. Combattere climate Change
 4. Aumentare l'indipendenza energetica dei paesi

Instrument	Brief explanation
Investment incentives	Capital Grants and all other measures aimed at reducing the capital cost of adopting renewable energy technologies.
Tax Measure	Economic instruments used either to encourage production or discourage consumption. They may have the form of investment tax credit or property tax exemptions, in order to reduce tax payments for project owner.
Incentive tariff	Price systems that guarantee above market tariff rates. In such cases, the Environmental authority generally sets a premium price to be paid for power generated from renewables.
Feed-in Tariff	Guaranteed price that may vary by technology. (Wind, Solar, Ocean, Geothermal, Biomass, Waste, Hydro).
Voluntary program	These programs generally operate through agreement between government, public utilities and energy suppliers, that agree to buy energy generated from renewable sources.

Obligations	Obligation and targets take generally the form of quota systems that place an obligation on producers to provide a share of their energy supply from renewable energy. These quota are not necessarily covered by a tradable certificate.
Tradable Certificate	Renewable energy Certificates (REC) are used to track or document compliance with quota system and can generally be traded in specific markets.
Public Research and Development	Public financed R&D program disaggregated by type of renewable energy
EU directive 2001/77/EC	Established the first shared framework for the promotion of electricity from renewable sources at European level.

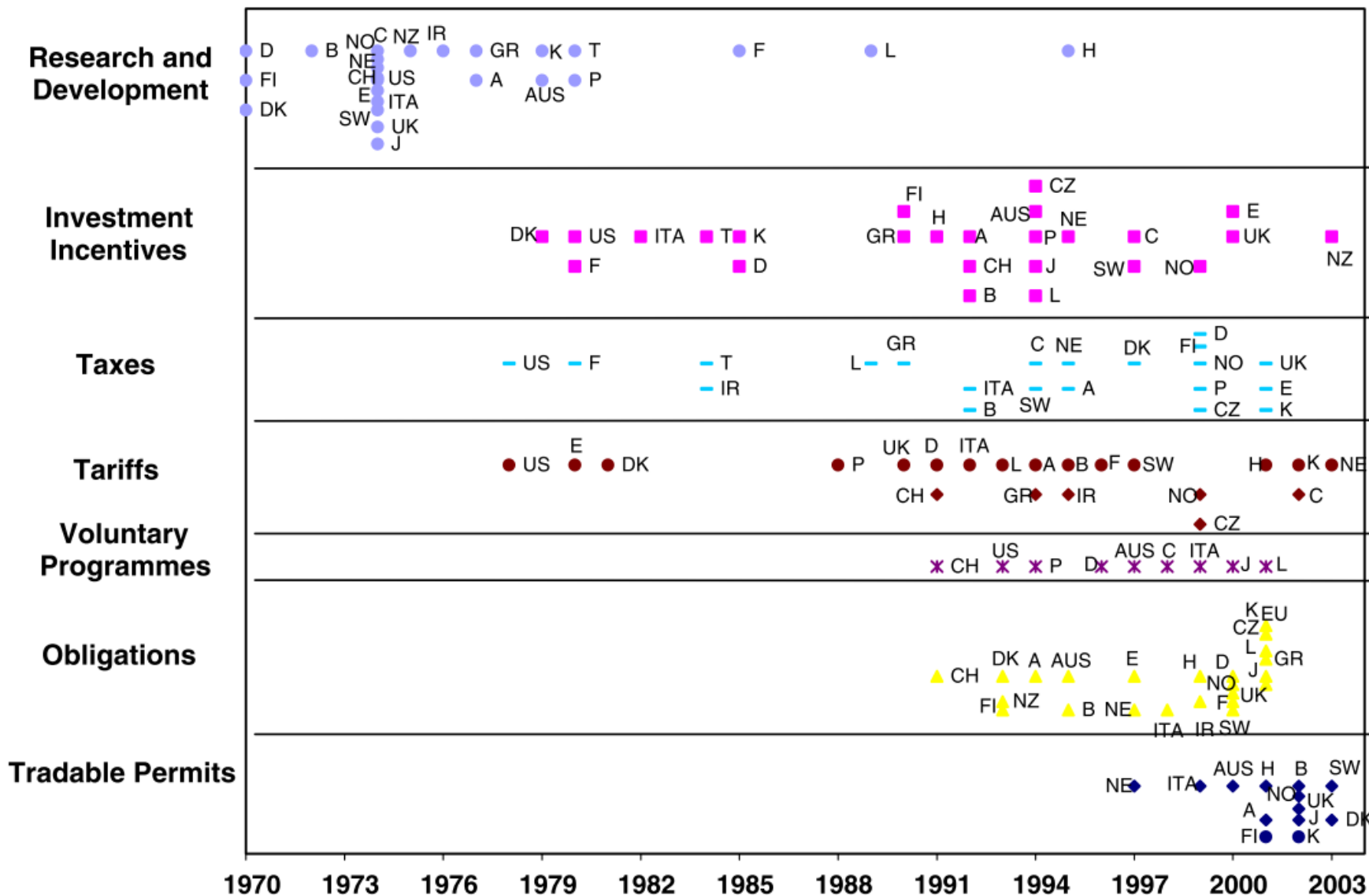


Fig. 3 Introduction of renewable energy policies by type in OECD countries. *AUS* Australia, *C* Canada, *FI* Finland, *GR* Greece, *ITA* Italy, *L* Luxembourg, *NO* Norway, *SW* Sweden, *UK* United Kingdom, *A* Austria, *CZ* Czech Rep., *F* France, *H* Hungary, *J* Japan, *NE* Netherlands, *P* Portugal, *CH* Switzerland, *US* United States, *B* Belgium, *DK* Denmark, *DE* Germany, *IR* Ireland, *K* Korea, *NZ* New Zealand, *E* Spain, *T* Turkey *Source:* IEA (2004)

Meccanismo

- Le politiche a sostegno per la domanda generano un incremento della dimensione del mercato per le rinnovabili. **Lo shock di domanda di conseguenza aumenta i ritorni attesi dalle spese in innovazione.**
- Le politiche che stabiliscono quote permettono la stabilizzazione di tecnologie rinnovabili già cost-effective.
- In generale riducono l'incertezza, che fa riferimento a:
i) incertezza riguardo alla domanda attesa; ii) incertezza riguardo agli investimenti della fase upstream e downstream; iii) incertezza riguardo agli investimenti delle imprese rivali

Meccanismo - 2

- Fasi diverse del ciclo di vita di una tecnologia richiedono strumenti di policy diversi
 - Fase emergente
 - Fase di sviluppo
 - Fase di maturità / affermazione
- A definire queste fasi sono i costi marginali di produzione
- Policy portfolio ottimale

Grado di liberalizzazione del Mercato

IDEA di Base:

In un mercato dell'Energia non liberalizzato, gli incumbent, ossia i grandi monopolisti dell'Energia, ostacoleranno la nascita di nuove imprese di tecnologie rinnovabili per sfruttare i loro vantaggi competitivi derivanti da alti **costi sunk** [sapete cosa sono?] e da una loro specializzazione in combustibili fossili e tecnologie tradizionali.

Elementi chiave

Vi sono più forze in gioco che possono ostacolare lo sviluppo di innovazioni ed in generale il mercato dell'energia:

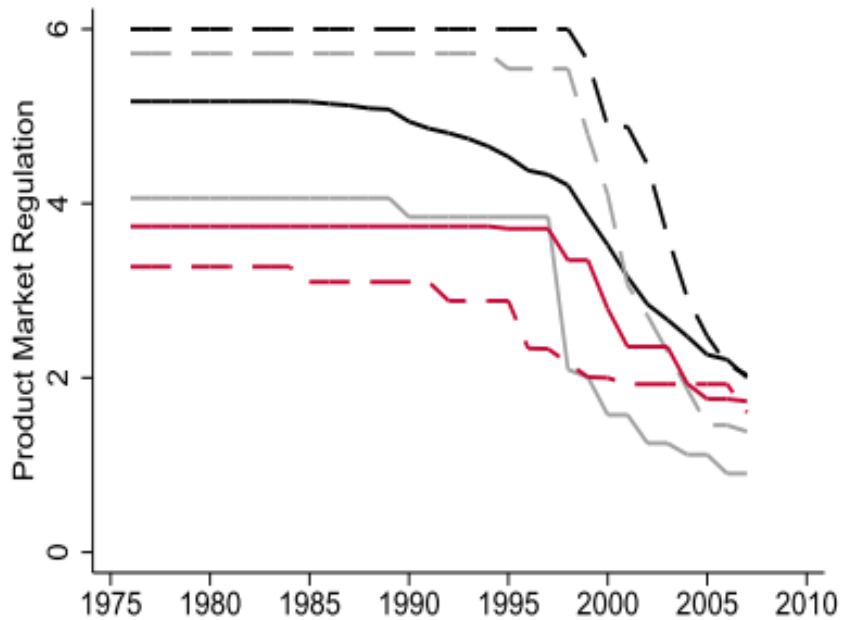
1. Barriere all'entrata
2. Integrazione verticale
3. Proprietà pubblica / privata
4. Costi Sunk e lobby di incumbent

Come è misurabile il grado di liberalizzazione nel mercato - PMR

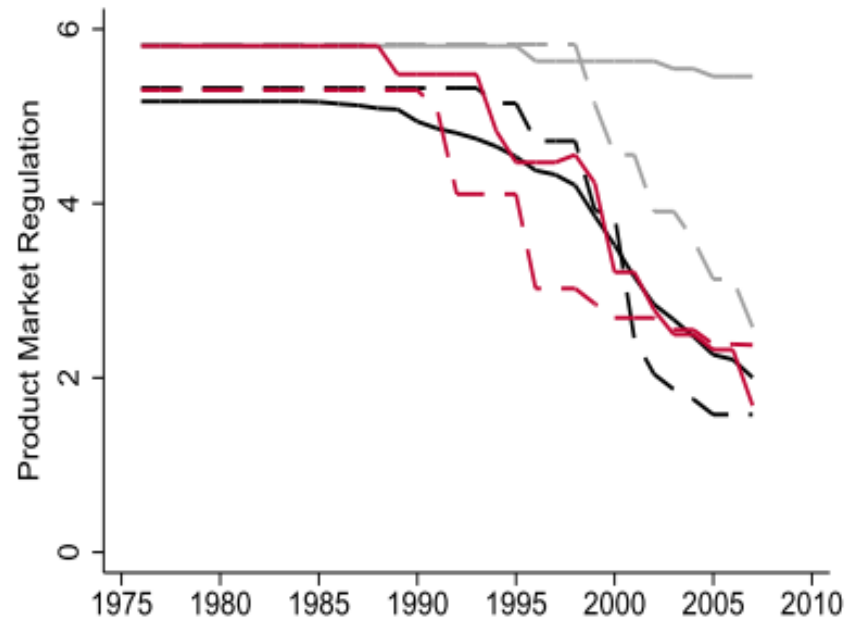
The product Market Regulation (PMR) index is built using common factor analysis by combining objective sector-specific policies and regulation from different data sources. The PMR index for electricity and gas aggregates three sub-indexes ranging from 0 to 6 (maximum anti-competitive regulation):

- 1. ownership:** private (=0), mostly private, mixed, mostly public and public (=6).
- 2. entry barriers:** that use information on third party access to the grid, regulated(=0), no access(=6) and minimum consumer size to choose supplier freely (from 'no threshold=0' to 'no choice=6').
- 3. vertical integration** ranging from unbundling (=0) to full integration (=6).

PMR-aggregato in paesi selezionati



— All countries - - France — Germany
- - Italy — Japan - - United States



— All countries - - Denmark — Mexico
- - Poland — Portugal - - Sweden

PMR per Entry, Vertical integration e Pubb Own

- Ownership unbundling, incrementando la competizione nel mercato, dovrebbe fornire incentivi all'innovazione. Dall'altro lato però, li frena, se i proventi derivanti dalle vendite di imprese verticalmente integrati vengono utilizzati per per merge orizzontali
- Privatisation ha un effetto dubbio, solo il pubblico internalizza le esternalità negative

Entry

- From a technological viewpoint, renewable energy innovations are radical and destructive for the centralized paradigm of energy production, which often rely on large-scale plants using fossil fuel or nuclear energy.
- On the contrary, renewable energy sources are generally produced by medium and small size firms
- Moreover, high sunk costs of large-scale generation exacerbate the lock-in of existing incumbents and, together with the expected obsolescence of their assets, feed their political opposition against the Distributed Generation paradigm

Entry

- Ogni nuovo entrante porta nuova conoscenza e altre risorse nel mercato
- Nuovi entranti possono creare nuove esternalità positive nel mercato

Nel caso delle rinnovabili il caso tedesco, ad esempio, è una riprova di questa tendenza.

Market Structure – Negative Schumpeterian Effect

More competitive markets **lower the appropriability of R&D investments**; an increase in competition in the energy sector should lower the incentive for innovation.

(appropriability: innovator's ability to capture profits generated by an innovation)

The basic Schumpeterian assumption states that competition **reduces innovative rents**.

(In the energy market for instance competition may reduce the profitability of the **down-stream sector [production-distribution; utilities]**, which translate to a lower demand for **upstream innovation [electric equipment manufacturers]**).

Market Structure – Escape competition

Aghion et al. (2001, 2005) developed models where an **escaping competition** effect counterbalances the standard appropriability effect. **In order to retain their market shares, incumbents are induced to invest more in R&D if the competitive pressure of new entrants is higher and they are close enough to the existing technological frontier.** On the other hand, higher pressure of new entrants discourages R&D investments of incumbents far from the frontier, whose competences are too distant from the ones needed to imitate leading-edge technologies.

Market Structure – appropriation effect

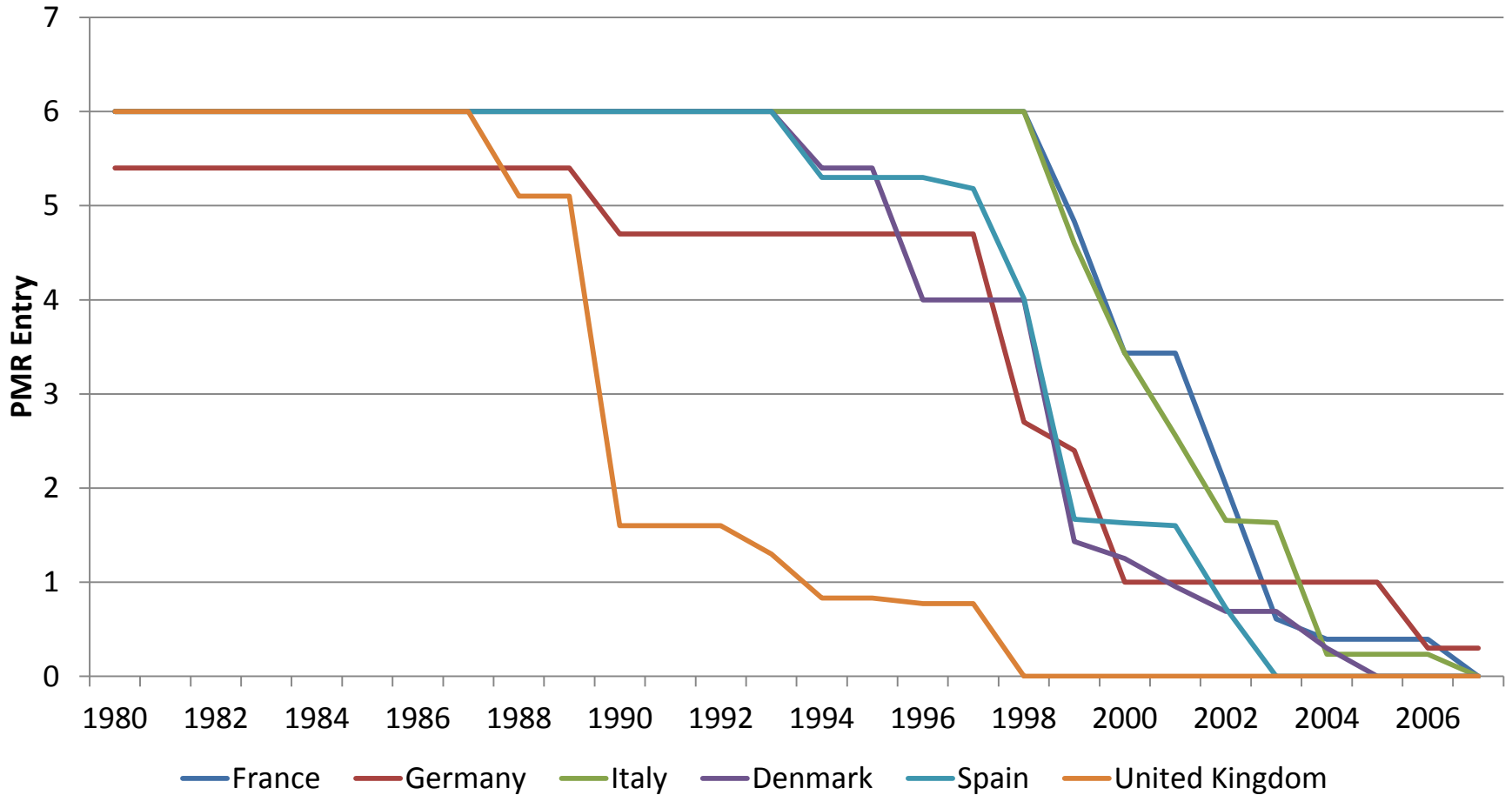
Sanyal & Ghosh (2013) show as in the Energy sector, there is also an **“appropriation effect”**, which is due to the entry of the non-utility generation firms in the wholesale market (general producing renewables – DISTRIBUTED GENERATION).

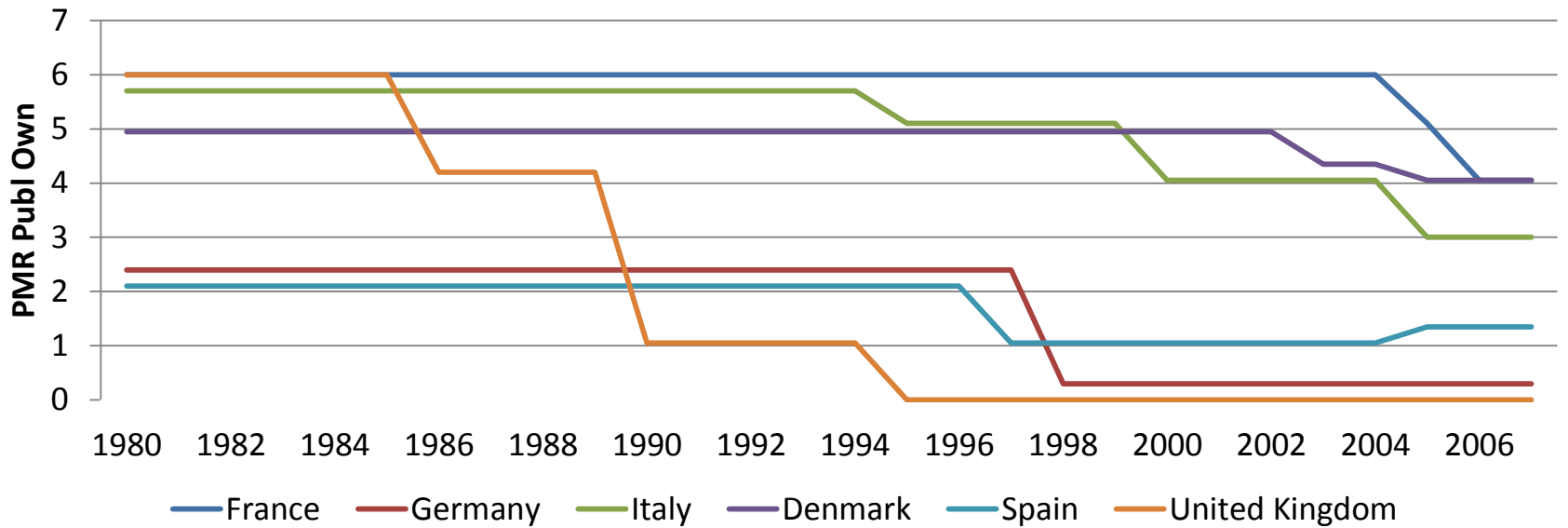
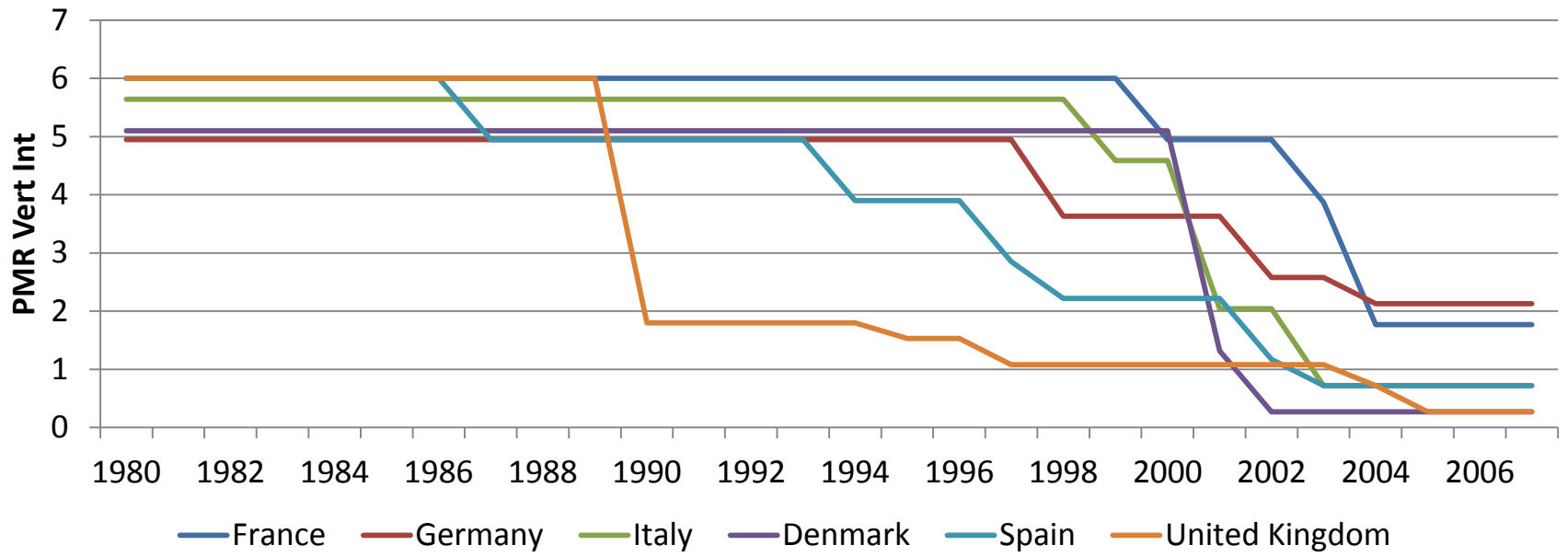
With an exogenous shift in downstream demand (i.e. exogenous from the point of view of the upstream Equipment Manufacturer (EEM)) due to Independent Power Producers (IPP) entry downstream, the size of the pie increases. **These IPPs will demand newer kinds of technology and this 'demand-push' will incentivize EEMs to increase their innovation effort**, since the upstream EEMs will now be able to capture a larger shares of this growing market.

Market Structure – summary of effects on innovation

EFFECT	Renewable Energy	Fossil Fuel Energy
Schumpeterian	-	-
Escape	+	-/+
Appropriation	+	+

Evidenze empiriche





Other control variables - Energy Price

“Consistent with the ‘induced innovation’ hypothesis, **the commercial viability of renewable energy is dependent in large part upon the its cost, relative to substitute factor inputs.** Since the costs of electricity production using renewable energy sources are generally greater than for fossil fuels, **an increase in the price of electricity should increase incentives for innovation in the area of renewable energies.** Since renewable sources represent a relatively small proportion of total electricity generation, it is assumed that the price of electricity can be considered exogenous “ (Johstone et. Al, 2010)

Other control variables - Electricity Consumption

As noted, returns on innovation are affected by the potential market for this innovation. In the case of renewable energy this is best reflected in trends for *electricity consumption*. **A growing market for electricity should increase incentives to innovate with respect to renewable energy technologies.** (Johstone et. Al, 2010)

Effetti eterogenei

Il grado di maturità di queste tecnologie influenza l'effetto delle determinanti sopra elencate

Esempio Wind Vs Solar