Measuring Eco-innovation

Results from the MEI project

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measuring ECO innovation

What is eco-innovation?

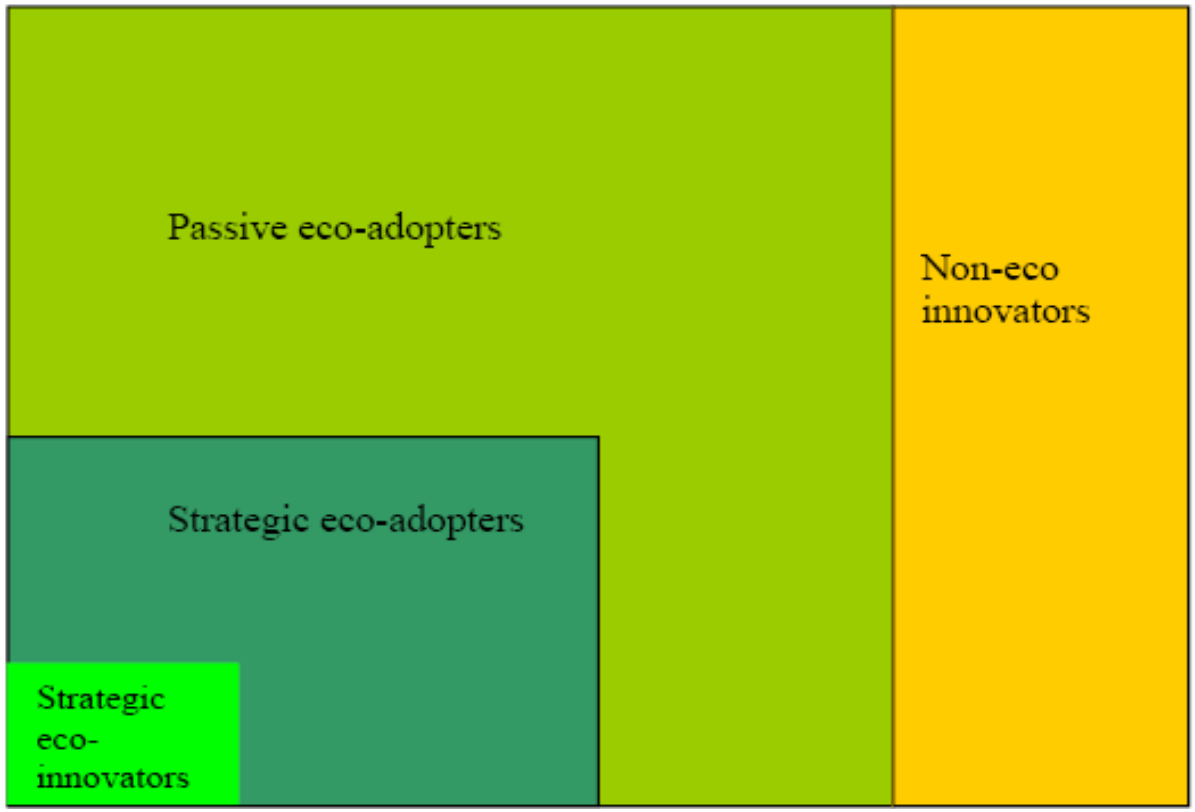
- **Eco-innovation** is the production, assimilation or exploitation of a product, production process, service or management or business methods that is **novel to the firm** and which **results**, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) **compared to relevant alternatives** (definition MEI project)

Many firms are eco-innovating in some way

- *By making their product lighter*
- *Making their production processes more resource efficient*
- *Introducing environmental management systems (organisational innovation)*
- *The use of pollution control technology, waste minimisation, …*

Often for **economic** reasons

Hypothetical distribution of innovating firms according to eco-activities



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- The relevant issue is **not whether companies are an eco-innovator or not**, but
- In ***what ways*** they are eco-innovating, for ***what reasons***, and what the ***effects*** are for the company, the environment and economy (Arundel and Kemp, 2009)

- Same as normal innovation, eco-innovation is a ***relative* concept**, not an absolute concept
- When measuring eco-innovation one should thus make clear whether one is measuring the **creation** of product innovations or the **implementation** of products, technologies, services and practices.
- Another distinction is whether the eco-innovation is an **incremental improvement** of something that exists or something entirely new, and whether the innovation is **environmentally motivated or not**.

Table 1. MEI classification of eco-innovation

A. **Environmental technologies**

- Pollution control technologies including waste water treatment technologies
- Cleaning technologies that treat pollution released into the environment
- Cleaner process technologies: new manufacturing processes that are less polluting and/or more resource efficient than relevant alternatives
- Waste management equipment
- Environmental monitoring and instrumentation
- Green energy technologies
- Water supply
- Noise and vibration control

B. **Organizational innovation** for the environment:

- Pollution prevention schemes
- Environmental management and auditing systems: formal systems of environmental management involving measurement, reporting and responsibilities for dealing with issues of material use, energy, water and waste. Examples are EMAS and ISO 14001.
- Chain management: cooperation between companies so as to close material loops and to avoid environmental damage across the value chain (from cradle to grave)

C. **Product and service innovation** offering environmental benefits:

- New or environmentally improved products (goods) including eco-houses and buildings
- Green financial products (such as eco-lease or climate mortgages)
- Environmental services: solid and hazardous waste management, water and waste water management, environmental consulting, testing and engineering, other testing and analytical services
- Services that are less pollution and resource intensive (car sharing is an example)

D. **Green system innovations:**

- Alternative systems of production and consumption that are more environmentally benign than existing systems: biological agriculture and a renewables-based energy system are examples

Eco-innovation indicators

- **Input measures**: Research and development (R&D) expenditures, R&D personnel, and innovation expenditures (including investment in intangibles such as design expenditures and software and marketing costs);
- **Intermediate output measures**: the number of patents; numbers and types of scientific publications, etc;
- **Direct output measures**: the number of innovations, descriptions of individual innovations, data on sales of new products, etc;
- **Indirect impact measures** derived from aggregate data: changes in resource efficiency and productivity using decomposition analysis.

Input measures: environmental R&D

- What share of R&D is devoted to "environmental" issues?
- For respondents and for research purposes the term environment often is too broad
- Our suggestion is to **break down the term environment into more meaningful categories** such as waste reduction, reductions in resource use, GHG emissions, pollution control and so on.

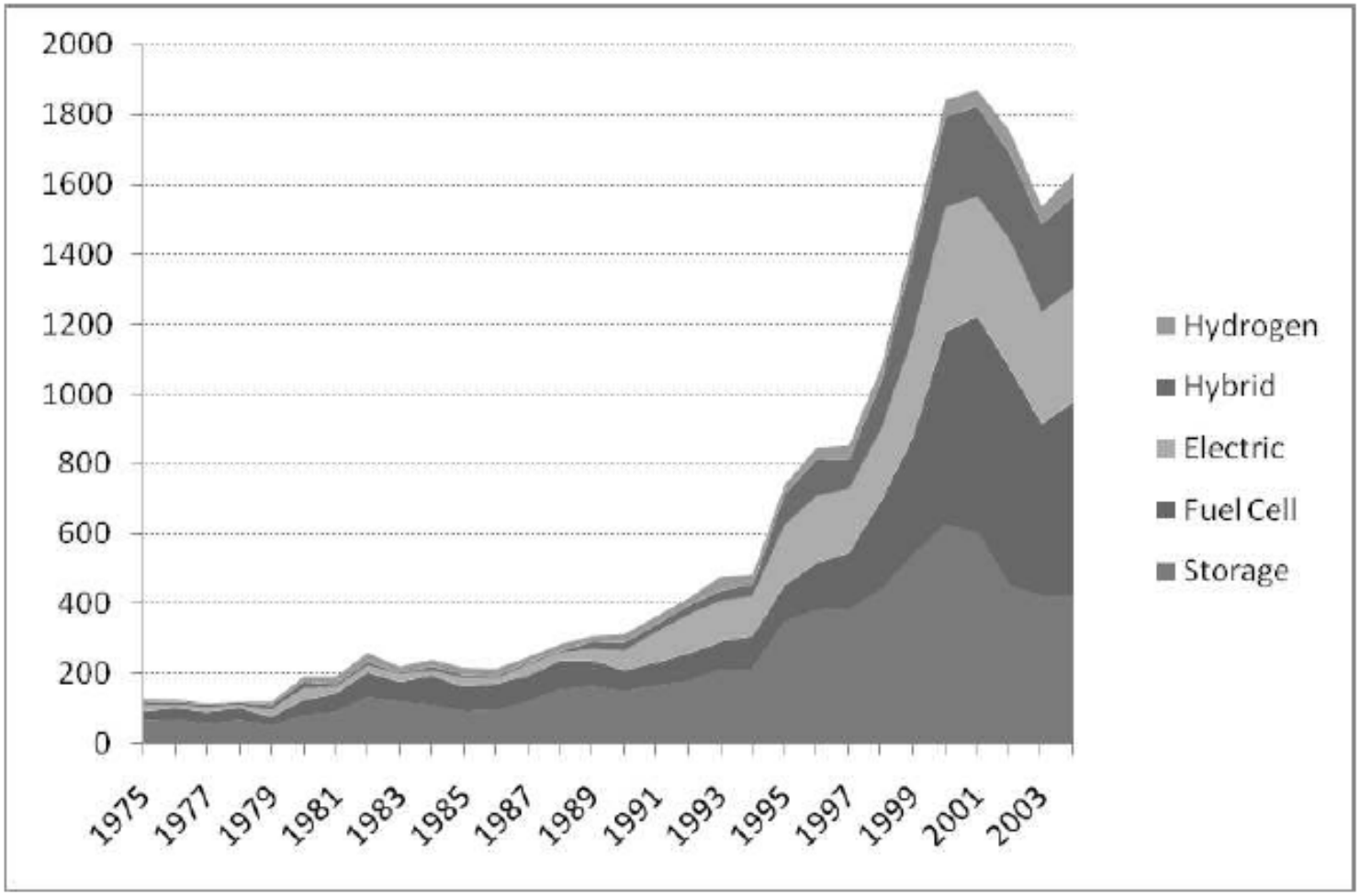
Intermediate output measures: patents, scientific publ. and citations

- Patents are the **most used** eco-innovation indicator
- Patents have several advantages over R&D expenditures: (*i*) they explicitly give an indication of inventive output, (*ii*) they can be disaggregated by technology group, and (*iii*) they combine detail and coverage of technologies (Lanjouw et al., 1998).
- They are based on an objective and slowly changing standard because they are granted on the basis of novelty and utility (Griliches 1990).

Some cautions

- **Not all eco-innovations can be usefully analysed through patent analysis**.
- Eco-patents mainly measure identifiable inventions that underlie green *product* innovations and *end of pipe technologies*, whose environmental impacts are specific aims and motivations of the inventions.
- Citation analysis helps to select relevant patents and eliminate patents that have no commercial application.
- For technology diffusion, service innovation and organizational innovation, patent analysis is **less useful** because many of these innovations are not patented.

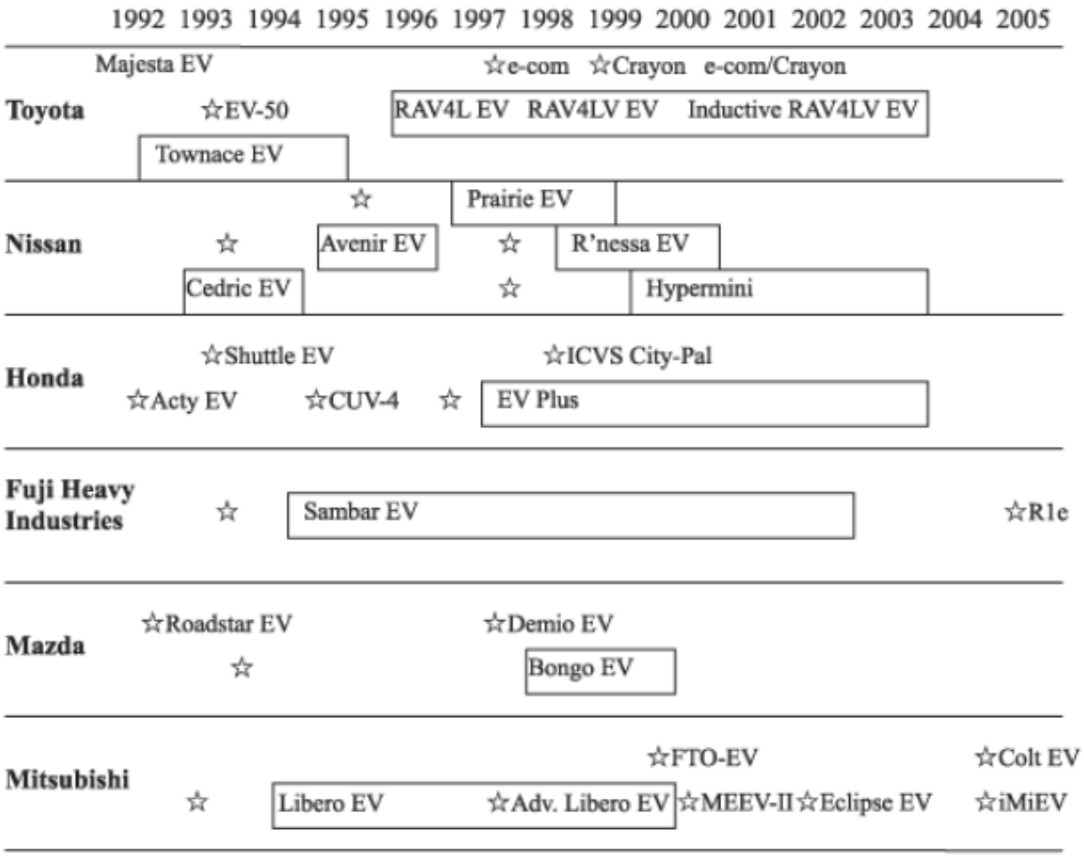
Figure 3. Development of Inventions with Respect to AFVs
(Claimed Priorities World-wide, 1975-2003)



Source: Johnstone and Hascic (2008a, p. 11)

Direct output measures: real innovations introduced in the market place

Figure 4. Development and commercialization of electric vehicles by major Japanese auto makers



Source: Yarime et al (2008) based on data from Center for Electric Vehicles (2006b) http://www.idrc.ca/en/ev-132155-201-1-DO_TOPIC.html#Ch10Fig2

- It is about **real innovations** of which innovation features may be mapped and statistically analysed; diffusion can be measured
- A real problem is that there are **few product databases with environmental information**. For specific products, a database of eco-innovation output could be created by sampling the 'new product announcement' sections of technical and trade journals or by examining product information provided by producers.

Indirect impact measures: eco-efficiency

- Eco-efficiency is a broad concept that is usually measured at the product or service level. Eco-efficiency means *less environmental impact per unit of product or service value* (WBCSD, 2000).
- ***Eco-efficiency = product or service value / environmental impact***

Conclusions

- **Eco-innovation research and data collection should not be limited to products from the environmental goods and services sector or to environmentally motivated innovations** but should cover all innovations with an environmental benefit, with research inquiring into the nature of the benefits and motivations for it.
- **Attention should be broadened** to include innovation in or oriented towards resource use, energy efficiency, greenhouse gas reduction, waste minimization, reuse and recycling, new materials (and eco-design. The drivers are related but different and the patterns of eco-innovation activity are likely to be different as well.

Conclusions continued

- For measuring eco-innovation, **no single method or indicator is likely to be sufficient**. In general, one should therefore apply different methods for analyzing eco-innovation – to see the "whole elephant" instead of just a part.
- **More effort should be devoted towards i) direct measurement of innovation output** using documentary and digital sources, and ii) changes in **eco-efficiency and resource productivity**.
- These two avenues are underexplored and should be given more attention, in order to augment our rather narrow knowledge basis.

Conclusions continued

- One area for future research (besides measuring what companies do in terms of eco-innovation) is the **macro-effects of eco-innovation**, to complement studies on the micro-effects.
- Measuring the **greenness of national systems of innovation** (green taxes, education, collaboration, venture capital, subsidy schemes, environmental standards, education relevant to green issues) constitutes another important avenue for research.

Conclusions continued

- It would be of interest to develop a **scoreboard for eco-innovation**. A first attempt was made in the MEI project, which came up with a list of 24 indicators for five categories: i) firms, ii) conditions, III) linkages, IV) radical/incremental innovation indicators, and V) overall performance
- We also propose a pilot project on company environmental performance data and eco-innovation activities. **Panel data** would be very suited for this.

As a last conclusion

- Additions to the Pollution and Abatement Cost (PAC) surveys would provide a relatively easy way of augmenting the international knowledge base on eco-innovation. This could offer information for benchmarking nations and sectors within nations, such as on the degree to which nations are shifting to cleaner production and waste reduction.
- They could inquire into R&D and other innovation expenditures and differentiate between investments on innovation and line extensions. Such surveys could also examine motivations, such as to reduce resource costs, improve products so that their use leads to lower environmental impacts and innovation offsets (gains from the introduction of environment-saving measures).