Is Energy Efficiency R&D (Research and Development) Really Effective? - A case in Japan -

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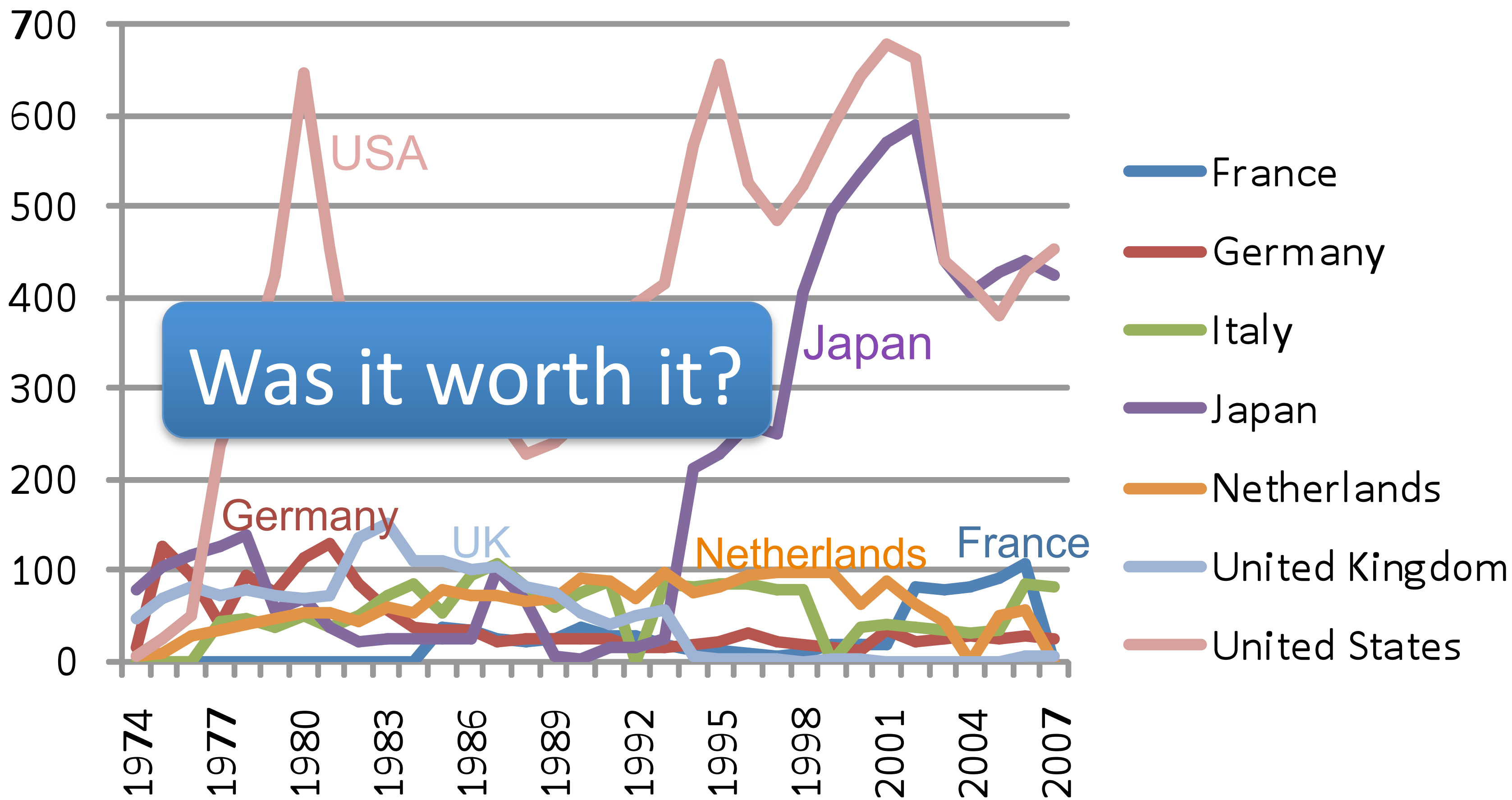
ECEEE 2009 Summer Study, La Colle sur Loup, France.

Public R&D in Energy Efficiency: An important policy instrument

[Mil. USD, 2004 prices and exchange rates]



(Source: IEA Energy RD&D Database 2008)

Research questions

1. What is the outcome of public R&D in energy efficiency?
   Has it produced any commercialized technology?

2. If there is any, how did it emerge? What were the key factors behind their successful commercialization?

Public R&D projects in energy technology in Japan, 1974-2002

Project		Period	Public funding [mil.USD]
Renewable Energy (solar, geothermal, wind)		1974-02	2472
Alternative Fuels (coal liquefaction/gasification)		1974-02	3088
Supply-Side Energy Efficiency (fuel cells, gas turbines, etc.)		1974-02	1764
Demand-Side Energy Efficiency			330
	Super-Heat Pump	**1984-92**	**(61)**
	Eco-Energy Network	**1993-02**	**(73)**
	Advanced Li-ion battery	1992-02	(147)
	Advanced electron devices	1998-02	(49)

(2002 price and exchange rage)

Technologies developed in the two case projects

Super Heat Pump Project	Eco-Energy Network Project
Heat pump (1) High efficiency heat pump type I (2) High efficiency heat pump type II (3) High output heat pump type I (4) High output heat pump type II ***Cooling medium*** (5) non-alcoholic mediums (6) alcoholic mediums ***Heat exchanger*** (7) Stainless steel plate-fin heat exchanger (8) EHD heat exchanger (9) Evaporator for mixed refrigerants ***Chemical thermal storage system***, using (10) Clathrate reaction (11) Hydration reaction by solute mixing (12) Hydration reaction (13) Ammonia complex (14) Solvation reaction (15) Metathesis reaction	***Waste heat recovery*** (16) Heat recovery from slag process in steel plants (17) Distillation column with internal heat exchange (18) LNG cold heat utilization technology (19) Thermoelectric generating system type I (20) Thermoelectric generating system type II (21) Waste heat recovery system using latent heat in exhaust gas ***Heat transport and storage*** (22) Heat transport system using methanol (23) Heat transport system using hydrogen absorbing alloy (24) High efficiency heat pump using hydrogen absorbing alloy (25) Heat transport system using vacuum insulation (26) Heat transport system using surfactant (27) Heat transport system using clathrate hydrate slurry ***Heat pump*** (28) High efficiency heat pump using multi-fuel gas engine (29) Compression/absorption hybrid heat pump (30) Absorption chiller using waste heat (31) Bidirectional thermosyphon heat pipe (32) Absorption pump using natural refrigerants ***Others*** (33) Flux measurement for contaminated fluid (34) Cold heat supply system using microsphere

Technologies with direct commercialization

Super Heat Pump Project

Heat pump

(1) High efficiency heat pump type I
(2) High efficiency heat pump type II
(3) High output heat pump type I
(4) High output heat pump type II

Cooling medium

(5) non-alcoholic mediums
(6) alcoholic mediums

Heat exchanger

(7) Stainless steel plate-fin heat exchanger
(8) EHD heat exchanger
(9) Evaporator for mixed refrigerants

Chemical thermal storage system, using

(10) Clathrate reaction
(11) Hydration reaction by solute mixing
(12) Hydration reaction
(13) Ammonia complex
(14) Solvation reaction
(15) Metathesis rea

Eco-Energy Network Project

Waste heat recovery

(16) Heat recovery from slag process in steel plants
(17) Distillation column with internal heat exchange
(18) LNG cold heat utilization technology
(19) Thermoelectric generating system type I
(20) Thermoelectric generating system type II
(21) Waste heat recovery system using latent heat in exhaust gas

Heat transport and storage

(22) Heat transport system using methanol
(23) Heat transport system using hydrogen absorbing alloy
(24) High efficiency heat pump using hydrogen absorbing alloy
(25) Heat transport system using vacuum insulation
(26) Heat transport system using surfactant
(27) Heat transport system using clathrate hydrate slurry

Heat pump

(28) High efficiency heat pump using multi-fuel gas engine
(29) Compression/absorption hybrid heat pump
(30) Absorption chiller using waste heat
(31) Bidirectional thermosyphon heat pipe
erants
fluid
sphere

Seven out of 34 technologies succeeded in commercialization

Technologies with growing market

Super Heat Pump Project	Eco-Energy Network Project

Super Heat Pump Project

Heat pump

(1) High efficiency heat pump type I
(2) High efficiency heat pump type II
(3) High output heat pump type I
(4) High output heat pump type II

Growing market

Cooling medium

(5) non-alcoholic mediums
(6) alcoholic mediums

Heat exchanger

(7) Stainless steel plate-fin heat exchanger
(8) EHD heat exchanger
(9) Evaporator for mixed refrigerants

Yet to be diffused

Chemical thermal storage system, using

(10) Clathrate reaction
(11) Hydration reaction by solute mixing
(12) Hydration reaction
(13) Ammonia complex
(14) Solvation reaction
(15) Metathesis

Eco-Energy Network Project

Waste heat recovery

(16) Heat recovery from slag process in steel plants
(17) Distillation column with internal heat exchange
(18) LNG cold heat utilization technology
(19) Thermoelectric generating system type I
(20) Thermoelectric generating system type II
(21) Waste heat recovery system using latent heat in exhaust gas

Limited installations

Heat transport and storage

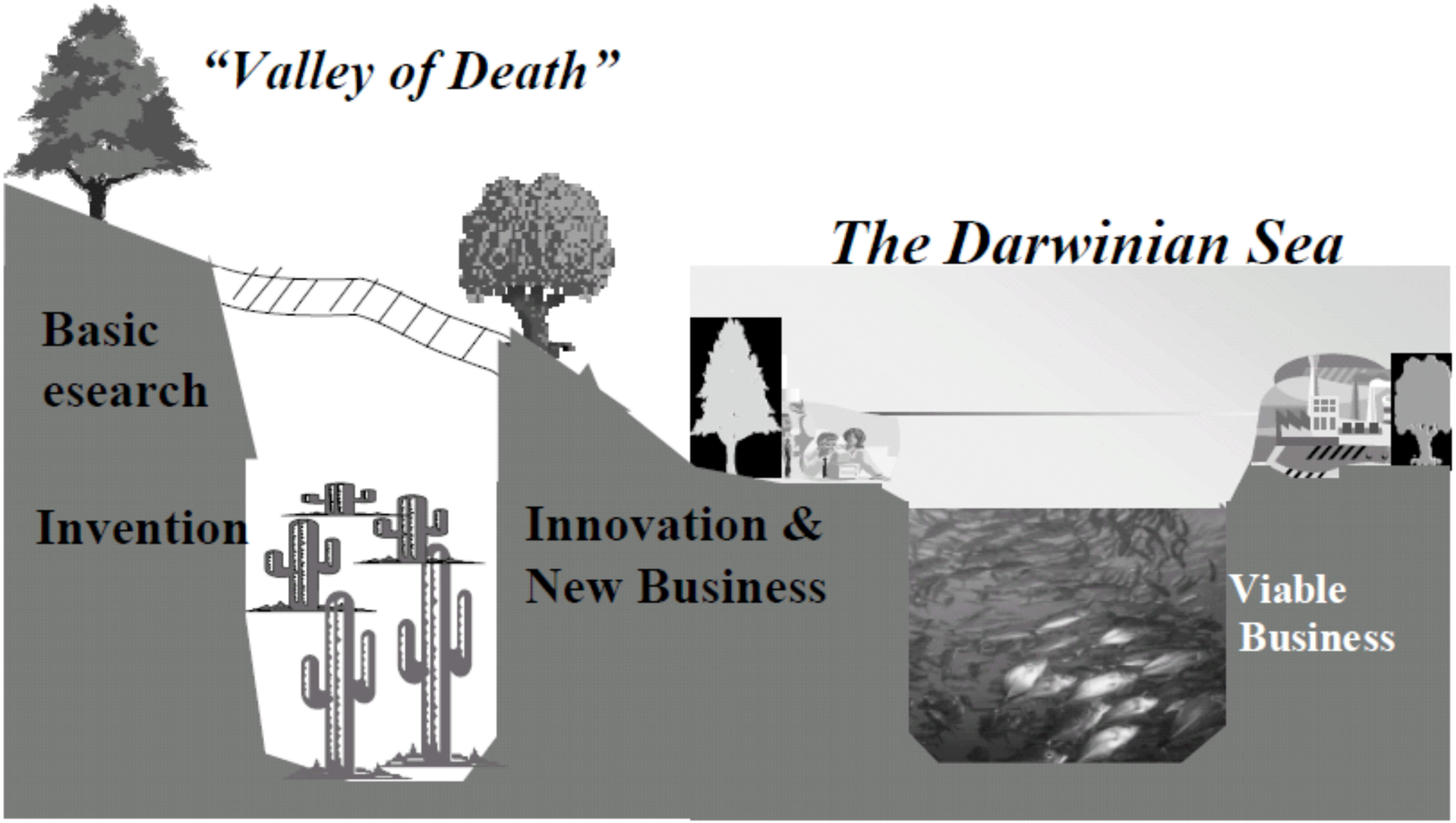
(22) Heat transport system using methanol
(23) Heat transport system using hydrogen absorbing alloy
(24) High efficiency heat pump using hydrogen absorbing alloy
(25) Heat transport system using vacuum insulation
(26) Heat transport system using surfactant
(27) Heat transport system using clathrate hydrate slurry

Heat pump

(28) High efficiency heat pump using multi-fuel gas engine
(29) Compression/absorption hybrid heat pump
(30) Absorption chiller using waste heat
(31) Bidirectional thermosyphon heat pipe

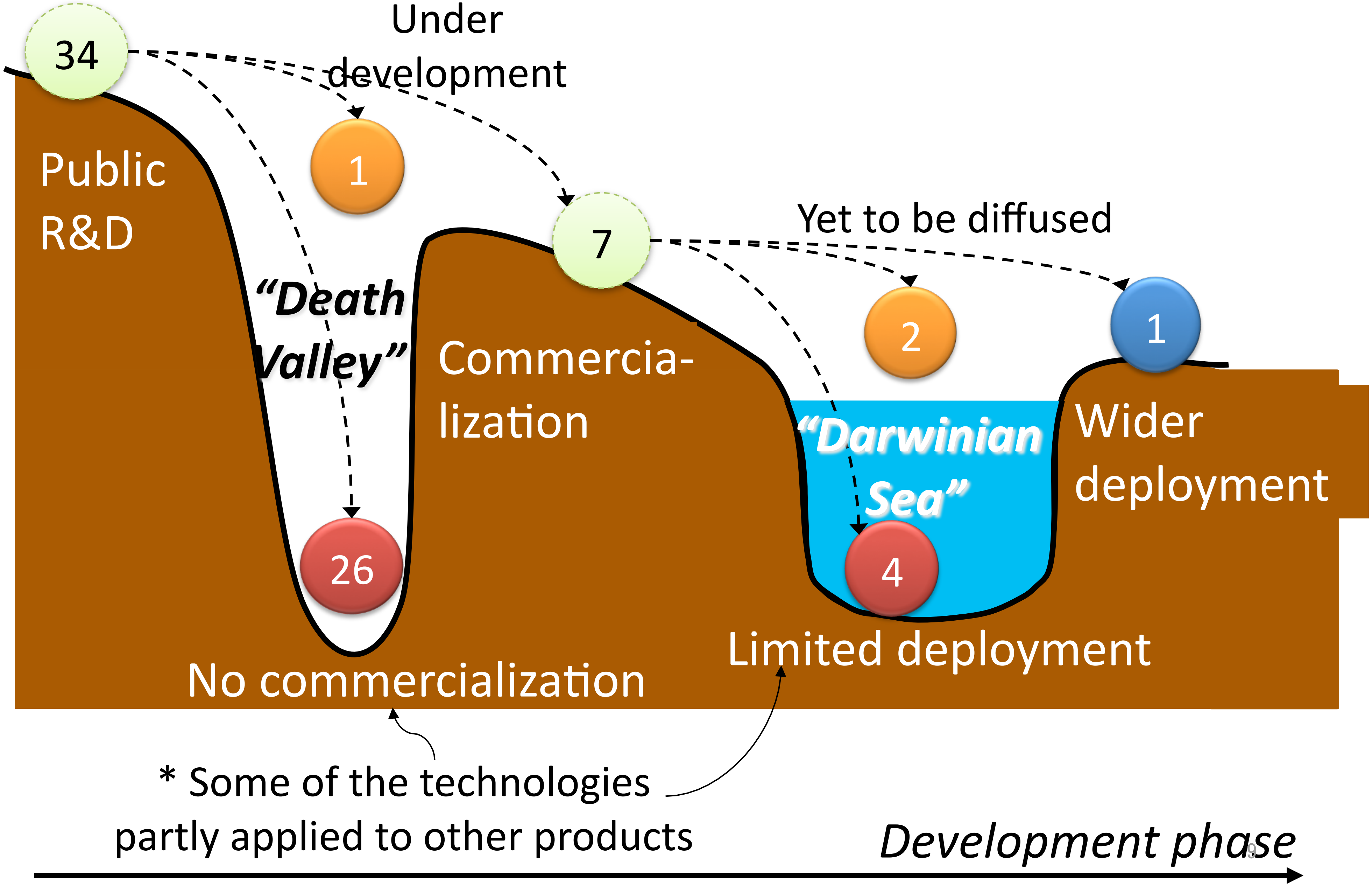
Four ended up in limited installations.
Only one with a growing market.

Death Valley and *Darwinian Sea*



(Wessener, 2001)

Status of the technologies developed in the projects



Two cases with successful commercialization

Case 1: High-efficiency heat pump

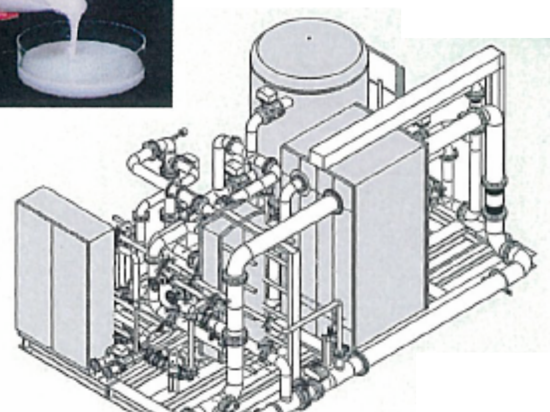
- 1.5 times more efficient
- More than 40 were sold. A successor product sold more than 700

High-Eff Mini
© Kobelco

How did they survive the Death Valley and the Darwinian Sea?

Case 2: Air-conditioning system using clathrate hydrate slurry

- More efficient by 10 to 30 %
- 9 were sold by 2007. More than 20 are under consideration.



Clathrate Hydrate Slurry Unit
© JFE Eng. Corp.

Four success factors

1. Long term public support
   – 7 to 15 years of R&D before commercialization
   – Follow-up projects were indispensable.
   – "*Keeping investing in such risky technology was impossible without public support*". (both cases)

2. Marketing and finding the right customers
   – Early adopters: Sony, Toyota, Panasonic, etc
   – Such users value innovativeness/environmental consciousness rather than economic disadvantage, forming initial niches.

Four success factors (cont.)

3. Diffusion strategy to expand the initial niche
   - Take balance between performance and cost
     e.g. sacrificing efficiency for reducing cost
   - Focus on a market segment with high competence
     e.g. limit the supply in a range of capacities without sever competition

4. Investment subsidy
   - Both cases eligible for subsidy. (one third of the investment cost/additional cost)
   - Reduce the cost disadvantage and payback time

Conclusions

1. While public R&D has high risk nature, it can bring new technologies some years later at a reasonable success rate.

2. Public R&D should be long-term and stable to induce private R&D into risky technologies.

3. Marketing is important to have greater impact.

4. Those imply the necessity of careful support of each development process by the government.

Thank you very much!

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Some topics for discussion

- Same in other countries?
- What is success/failure of public R&D?
- How about the spillover effect?
- Was the success rate reasonable? Why?
- What can we learn from failure projects?
- Public R&D has to be risky, but at the same time should not be wasted. How to maintain both?
  - Select risky but promising technologies
  - Long-term but flexible (in order not to be captured by unpromising technologies)
- Marketing is important. But how to support it?
  - Subsidy is not always effective…