

Energy Innovation in Germany, Japan, and Brazil

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Critical Elements for Innovation

- Strong, integrated government structure to support innovation system
- Good universities to train researchers and innovators
- High-quality research institutions (research universities, research laboratories)
- Capable private sector institutions with R&D capacity and ability to carry innovation forward into products and services
- Market “push” policies to drive research forward into development (including over “Valley of Death”)
- Market “pull” policies to drive demand for new products

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UNIQUE ELEMENTS OF GERMAN ENERGY INNOVATION SYSTEM

Research and Development

- In reaction to concerns about competition/weakness of research capacity, recent new emphasis on R&D, some from economic stimulus:
 - Increased R&D support from both government and private sector
- In energy, research priorities of national government include:
 - Renewable energy
 - Energy efficiency, especially for the built environment, including cities
- Carbon dioxide capture and sequestration
 - Geologic storage of CO₂
 - Zero emissions power plants
- Mobility innovation (new drive systems, fuels, intelligent traffic infrastructures)

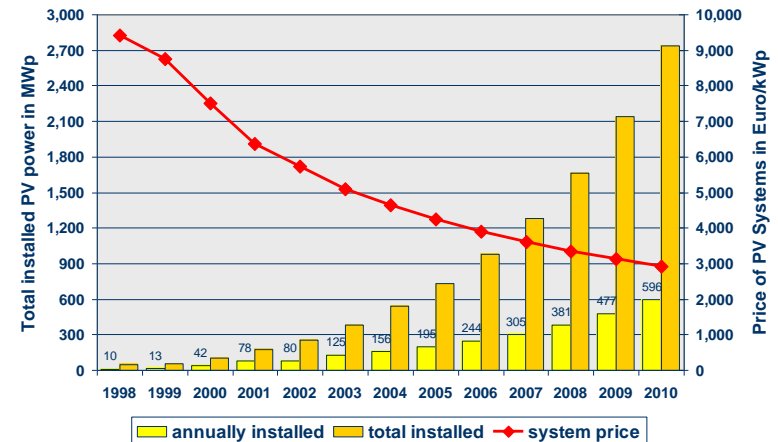
Innovation Institutions

- Strong academic education opportunities in energy
 - Include the “TU9” Institutes of Technology, created during the age of industrialization
- Good national program of research centers working on energy issues:
 - Helmholtz Association of National Research Centres
 - Group of basic research institutes funded primarily by German government
 - Fraunhofer Society
 - Set of institutes focused primarily on applied research
 - Funding framework, known as “Fraunhofer Model”, predicated receipt of German government funds on entrance into research contracts with private sector entities
- Greater emphasis on improving framework conditions for innovations to move into private sector
 - Facilitating start-up companies
 - Increased emphasis on public procurement of new technologies
 - Use of standards to drive innovation
 - Facilitating innovation financing, especially from private sector

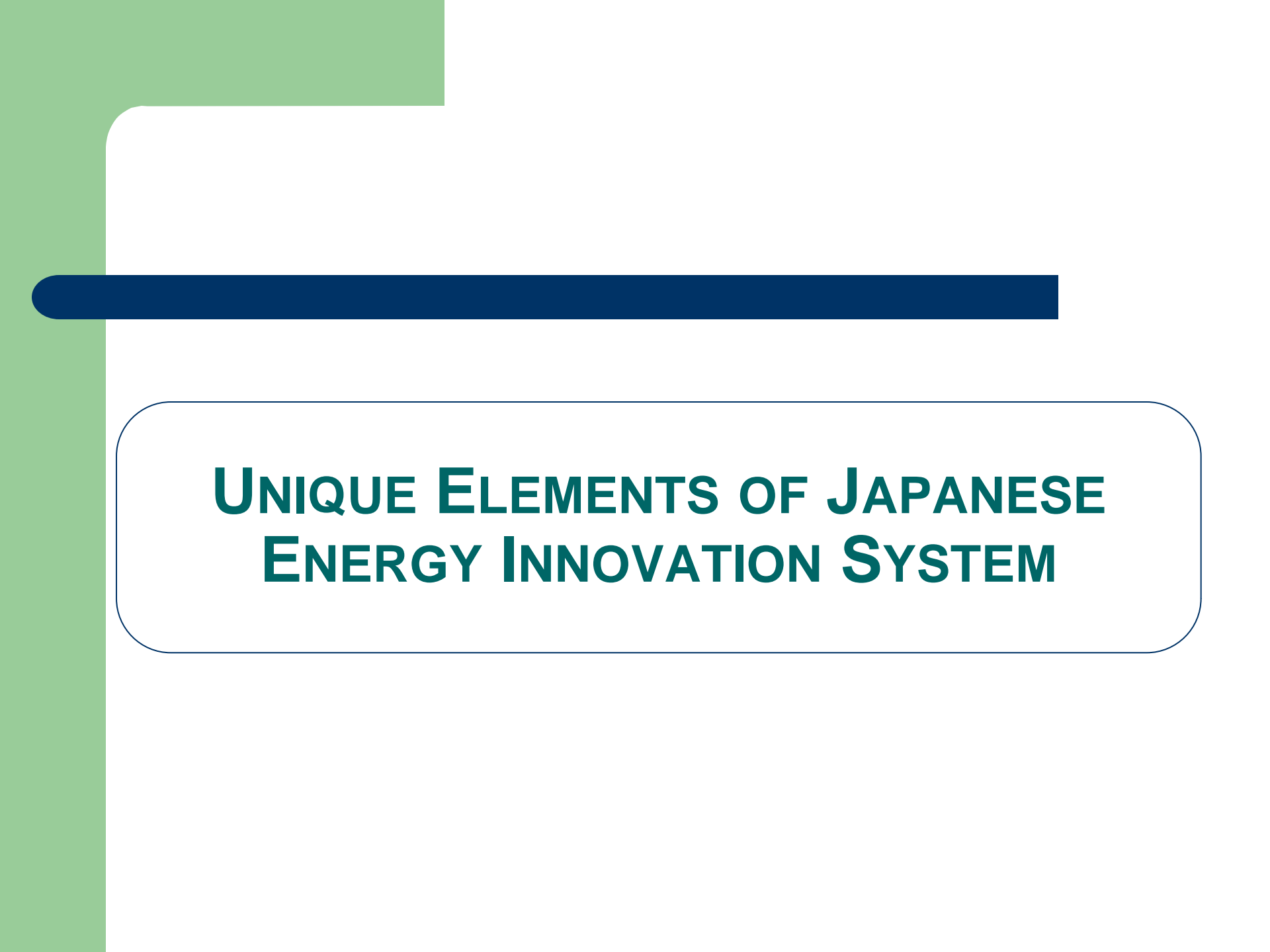
Consistent Market “Pull” Policies

- Stable and long lasting menu of incentives and standards to pull new technologies forward
- Include:
 - Feed-in tariffs (FIT) for renewable resources (purchaser pays a higher tariff, which declines over time; in Germany, FIT is for 10 years)
 - Building regulations
 - Appliance and lighting efficiency standards
 - Biofuels blending targets
 - Vehicular efficiency targets
 - Procurement policy for new technologies
 - Requirement that sustainability be built into national government buildings
 - Establishment of a building energy efficiency label
 - Subsidies and tax incentives for sustainable energy investments in new and existing buildings

Illustration of Market “Pull” Policies



Impact of Market Pull Strategies on PV Prices



UNIQUE ELEMENTS OF JAPANESE ENERGY INNOVATION SYSTEM

Historical Drivers of Energy Innovation

- Keiretsu structure of much of industry
- Ministry of International Trade and Industry (MITI)
 - Created in 1949 to coordinate international trade policy
 - Architect of industrial policy
 - Provided industry with administrative guidance on modernization, technology, investments in new plants and equipment, domestic and foreign competition
 - Major emphasis on importance of R&D
 - In 2001, reorganized and folded into Ministry of Economy, Trade and Industry (METI)

Keiretsu Structure

- Defined as a set of companies with interlocking business relationship and shareholdings
- Developed in post-war era
- Keiretsu can be vertically or horizontally integrated:
 - Vertically integrated refers to interwoven structure within a single company, usually connecting all factors needed for the production of a product
 - Toyota considered the biggest of this type of structure
 - Horizontally-integrated keiretsu refers to interwoven structure involving at least one major bank/trading company and a variety of industries
- Bank has major control over the companies in this type of keiretsu, acting as a monitoring entity and an emergency bail-out entity
- Six major postwar keiretsu:
 - Mitsubishi
 - Mitsui
 - Sumitomo
 - Fuyo
 - Dai-Ichi Kangyo
 - Sanwa
- Keiretsu structure has weakened in past two decades due to adverse impacts on banks by recession of 1990 and emergence of companies from outside keiretsu system that outperformed their counterparts (e.g., Sony)

Benefits of Keiretsu Structure

- Ready source of finance
- Protection against hostile takeover
- Integrated supplier framework
- Integrated distributor framework
- If managed well, can obviate bankruptcy

Energy R&D

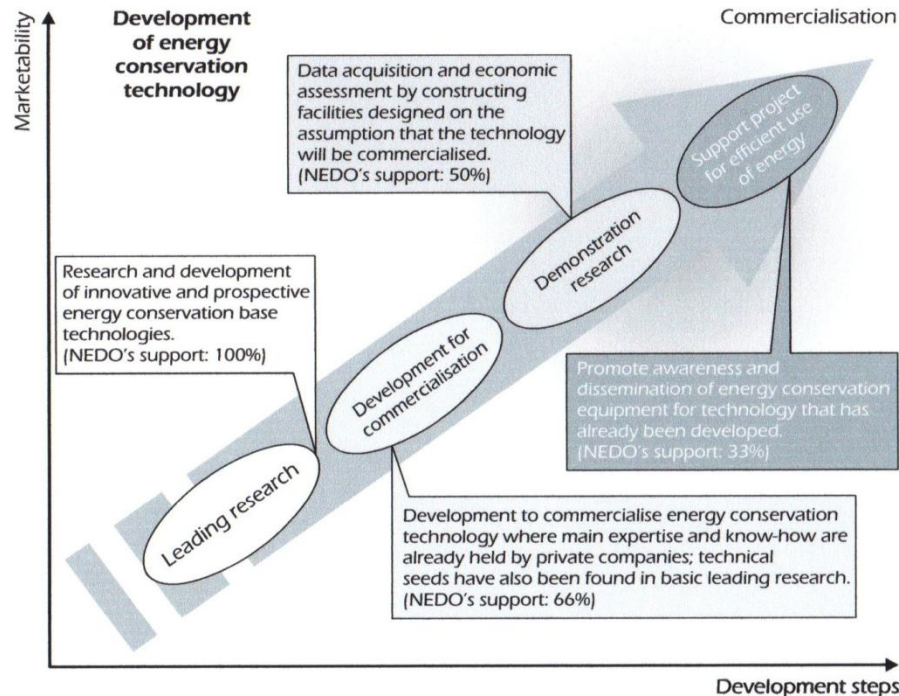
- Government spending on overall R&D as percentage of GDP is largest among IEA member countries
- Manifestation of greater emphasis on “market push” rather than “market pull” strategies

Important Energy Innovation Institution: NEDO

- New Energy and Industrial Development Organization
 - Established in 1980 as semi-governmental institution under METI
 - Defines a process of bringing innovation forward from R&D to commercialization that includes a lessening percentage of governmental support
 - Activities include:
 - Development of new energy and energy efficiency technologies
 - Management, including energy management, of industrial technologies
 - International cooperation in technology development

NEDO and Energy Efficiency Innovation

Example of NEDO Funding Support Levels for the Development of Energy Conservation Technologies



Source: NEDO.

NEDO and Solar Energy Innovation

- Photovoltaic R&D started in 1974 as part of Sunshine program
 - Goal to reduce the cost of a PV by factor of 100
 - NEDO played central role in promoting this project
 - Focus on system as a whole
 - Research simultaneously on thin film amorphous silicon cells, manufacturing technologies to produce the cells and system technologies to enable integration of PVs on rooftops

Cool Earth 50's Relatively New Energy Innovation Institution



- Created in 2008 to respond to goal of reducing global greenhouse gas emission in 2050 by 50%
 - Selected 21 key technologies to be given priority
 - Technology “roadmaps” created for highest priority technologies that prescribes R&D priorities and performance benchmarks
 - Seeks also to strengthen international cooperation on R&D to accelerate innovative technology development

Cool Earth 50's Technology Priorities

Key Innovative Technologies towards *Cool Earth 50*

	Efficiency improvement	Low carbonisation
Supply side	Power generation and transmission 1. High-efficiency natural gas-fired power generation 2. High-efficiency coal-fired power generation 6. High-efficiency superconducting power transmission	3. Carbon capture and storage (CCS) 4. Innovative photovoltaic power generation 5. Advanced nuclear power generation
	Transportation 7. Intelligent transport systems 8. Fuel cell vehicles	9. Plug-in hybrid vehicles /electric vehicles 10. Production of transport biofuels
Demand side	Industry 11. Innovative materials, production/processing 12. Innovative steelmaking processes	
	Commercial 13. High-efficiency housing and buildings 14. Next-generation high-efficiency lighting 15. Stationary fuel cells	
	16. Ultra high-efficiency heat pumps 17. High-efficiency information devices and systems 18. Energy management systems (HEMS/BEMS/local-level EMS)	
	Cross-cutting 19. High-performance power storage 20. Power electronics 21. Hydrogen production, transport and storage 3. CCS (repeated)	

Source: Country submission.

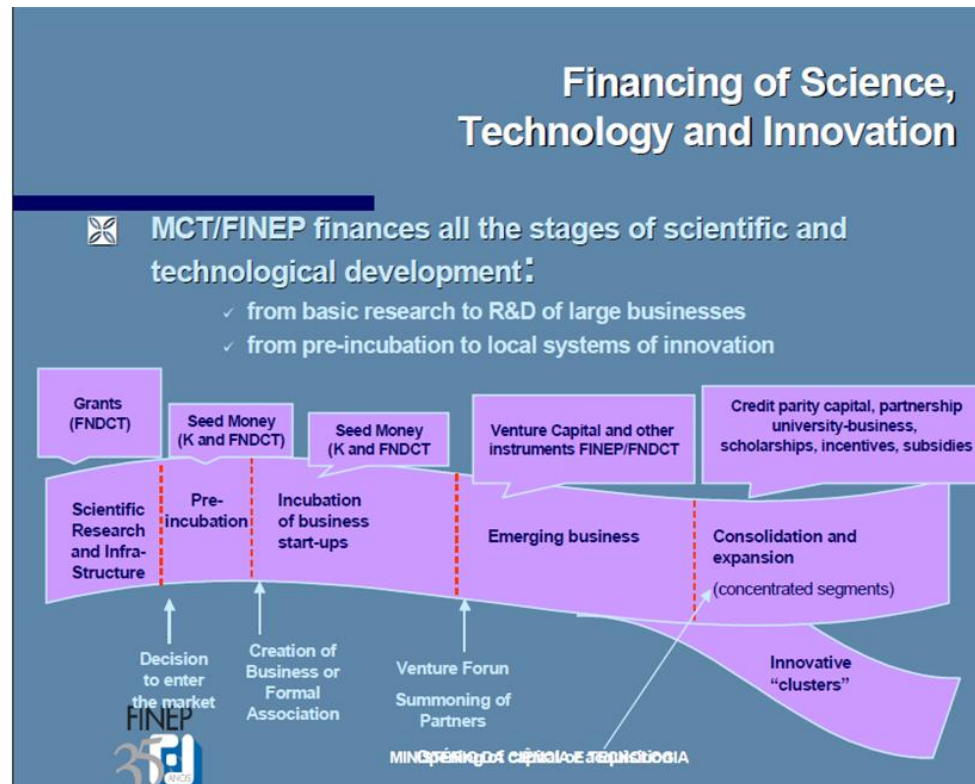


UNIQUE ELEMENTS OF BRAZILIAN ENERGY INNOVATION SYSTEM

Important Innovation Institution: FINEP

- Brazilian Innovation Agency
- Public institution within Ministry of Science and Technology
- Plays important role in bringing R&D into commercialization
 - Provides grants to non-profit institutions (universities, research institutions)
 - Lends money to companies for development of innovations
 - Executive Secretary of Funding for Scientific and Technological Development (FNDCT), which has been reinvigorated with Science and Technology Sectorial Funds
 - Includes those focused on oil and gas, energy, hydro resources, agribusiness, transportation
 - FINEP funding has included:
 - Embrapa (Brazilian Agricultural Research Corporation)—very competitive, has worked on feedstock for biofuels
 - Petrobras, for deep water oil exploitation

Market “Push” Approach of Government



Focus on INOVAR

- Launched in 2002 in recognition of the lack of adequate venture capital market
- Co-funded by Brazilian government institutions and Inter-American Development Bank
- Goal has been to gain co-investment from pension funds, private investors
- Established 25 funds and a Seed Money program to provide early stage funding for small entrepreneurs
 - Supported by a venture capital website to enable entrepreneurs to link up with each other

Other Actors involved in Specific Sectors in Energy R&D

- Electricity sector

- Requirement by electric utility regulator, ANEEL, that privatized utilities allocate ~1% of annual revenue to R&D and energy efficiency
 - Half is kept within the utility, with increasing requirement to look at end-use
 - Half goes to new institution, CT-Energ (to focus on public good)
 - Mandated focus is on:
 - Provision of electricity to remote rural areas
 - Diversification of electricity supply away from large hydro
 - Development of highly energy efficient

technologies with social benefits

- Feedstock for biofuels

- EMBRAPA, working with state institutes and universities, has focused on:
 - Development of hardy feedstock, requiring lesser levels of water and fertilizer, with high output per hectare (3-fold increase in 29 years) and a higher sugar content
 - Development of second-generation cellulosic feedstock for ethanol

Market “Pull” Strategies of Government

- PROACOOOL Program
 - Variety of requirements and incentives to support development of alcohol fuels and vehicles to run on them
 - Now being expanded into biodiesel
- PROINFA
 - Program to contract power from small hydro, biomass and wind producers; financing provided
 - Target of 10% electricity from these sources by 2020