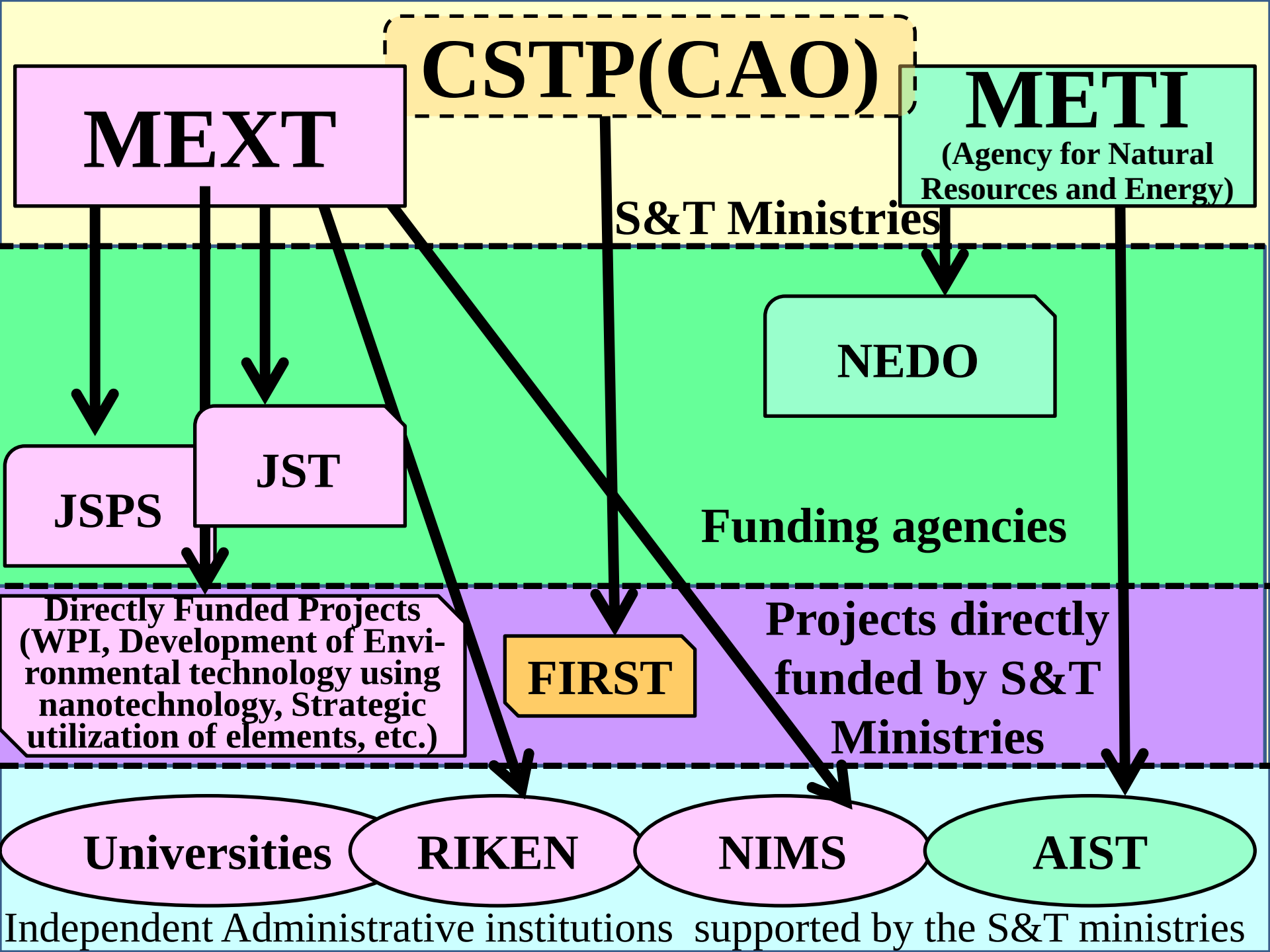
Funding and Direction in Renewable Energy Research in Japan

Kohei UOSAKI

International Center for Materials Nanoarchitectonics (WPI-MANA) and Global Research Center for Environment and Energy based on Nanomaterials Science (GREEN)

National Institute for Materials Science

Nanotechnology and Materials Unit, CRDS, JST


CSTP(CAO)
MEXT
METI
(Agency for Natural Resources and Energy)
S&T Ministries
NEDO
JST
JSPS
Funding agencies
Directly Funded Projects (WPI, Development of Environmental technology using nanotechnology, Strategic utilization of elements, etc.)
FIRST
Projects directly funded by S&T Ministries
Universities
RIKEN
NIMS
AIST
Independent Administrative institutions supported by the S&T ministries

Cool Earth – Energy innovation technology plan
METI, March 2008

Energy Supply

Energy consumer

Efficiency enhancement

Generation/ transmission

① Efficient LNG power generation

② Efficient coal power generation

6. Superconducting transmission

Low carbon

3. CO_2 capture and storage (CCS)

④ New solar cell

⑤ New nuclear power

Trans.

7. High level traffic system

⑧ FCV

⑨ PHV

EV

15. Fuel production from biomass

Industry

⑪ Novel material/ production/ processing

⑫ Novel iron manufacturing process

Industry

⑬ Energy conser-vation bldg.

⑭ New generation lighting

⑮ Stationary FC

16. Super efficient heat pump

17. Energy conserv. information system

⑱HEMS/BEMS/ Regional EMS ※

Inter-division

⑲ High performance elec. storage

⑳ Power electronics

㉑ Hydrogen production/ transportation/storage

③CCS（再掲）

※EMS：Energy Management System、HEMS：House Energy Management System、BEMS：Building Energy Management System

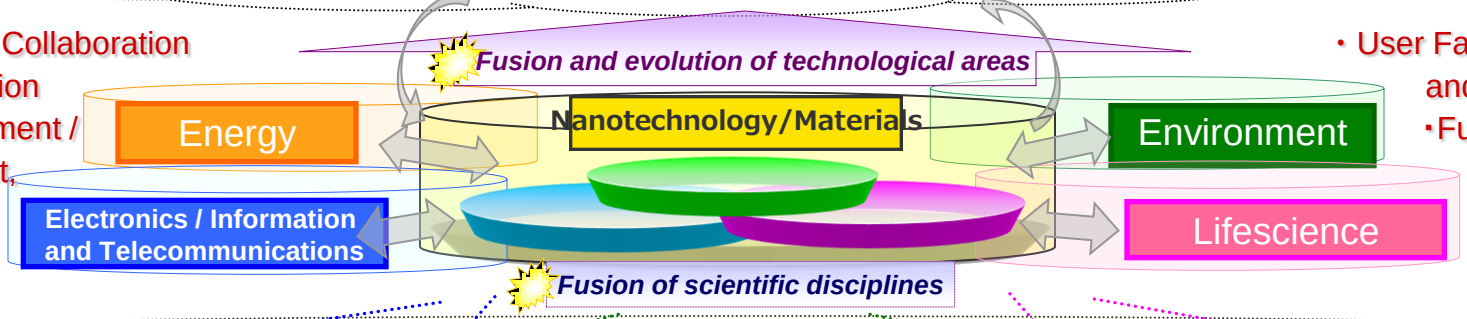
Major Issues in Nanotechnology / Materials

CRDS JST

Sustainable and Environmentally friendly Society

- International Collaboration
- Standardization
- Risk Assessment / Management, Regulation

- User Facilities network and R&D centers
- Funding systems
- Human Resources / Education



Nanoelectronics

Energy Saving
- Ultra Low Power Devices
- Carbon-based Nanoelectronics
- Non-volatile Memory・CPU

Multi-functional System
- Fusion of nano-CMOS and Spin・Photonics・Bio・MEMS
- Smart-interface (Smart-sensor・Robot、High-resolution Display、Wearable PDA)

Ultra-high-speed Computation
- Quantum Computer
- Nano-photonics

Green Nanotechnology

Energy Generation
- Solar Cell with High Efficiency and Low Cost
- Thermo-electric device, Fuel Cell
- Biorefinery
- Artificial Photosynthesis (Hydrogen・Fuel Production)

Energy Transmission & Storage
- New battery Cell Material, Superconductor Material

Energy Saving
- Thermal Insulating Structural Material, Light Weight Material for Transportation
- Complex Total Energy System

Environment Protection
- Membrane Separation (Water, Gas)
- Environment Monitoring System with High Sensitivity & Selectivity
- Green Process, Replacement for Rare Natural Resource

Nanobiotechnology

Innovative nano-medical technology
- Drug delivery・Intracellular injection
- Implant devices for the diagnosis and treatment
- Materials for Regenerative medicine

Application of biological systems to sustainable system
- Environmental cleanup by imitating photosynthesis
- Environmental Monitoring by biomaterial

Application of biological systems to other fields
- Devices using self-organization
- Biomimetic ultra low power IT

New Substances / Materials

・New Magnetic Material ・Corrosion Resistive & High-refractory Metal ・Wide-gap Semiconductor・Oxide Semiconductor ・Composite・Hybrid Material ・New Structured・Space & Gap Material ・Molecular & Organic Material ・Bio-Material

Common & Basic Technology in Nanotech /Control Technology in Substances & Materials ／ Nanoscience

Material Preparation and processing
- Self-organization/Hierarchical Control of structure
- Integration of Bottom-up & Top-down processes
- Nano & Micro Printing, 3D nano-fabrication

Theory & Design
- Exploration and design of new material, Element Strategy
- Design for nano-system, Theory for surface & Interface

Nano-scale Measurement & Analysis
- Three dimensional Imaging, Visualization, Dynamic Measurement
- Measurement for surface, bulk and Interface
- In-situ Measurement

New Energy and Industrial Technology Development Organization (NEDO)

■ **Energy and Environmental Technologies**

•Energy	Photovoltaic and solar thermal	Wind
	Biomass	Geothermal and hydraulic
	Fuel cells and hydrogen	Energy conservation
	Smart community	Electricity storage
	Field tests	Introduction and Discussion
	Coal resource development	
•Environ-ment	3R (Reduce, Reuse, Recycle)/Water recycling	HFC, PFC, and SF6 measures
	Chemical substance management	Clean coal

Funding Program for World-Leading Innovative R&D on S&T (FIRST)

CAO (CSTP) 1250 M$/30 PJ/5y

Solar, Battery, Low power devices

Japan Society for Promotion of Science (JSPS)

Grant-in-Aid

Specially Promoted Research 5M$/5y

e.g., water splitting photocatalysts

Japan Science and Technology Agency (JST)

Strategic Basic Research Programs

CREST (Core Research for Evolutional Science and Technology):<6M$/5yx15

Solar energy, Energy conv. Interphase, CO_2 Emission Control

PRESTO (Precursory Research for Embryonic Science and Technology): <0.5M$/3y x 30/PJ

ERATO (Exploratory Research for Advanced Technology): <25M$/5y

Hashimoto Light Energy Conversion

ALCA (Advanced Low Carbon Technology Research and Develop-ment Program): 50M$/y, ~ 3M$/5y

Solar, Supercond., Elec. storage, Heat res. mat., Biotech, Chem. proc, Device

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Roadmap of PV2030+

(NEDO June, 2009)

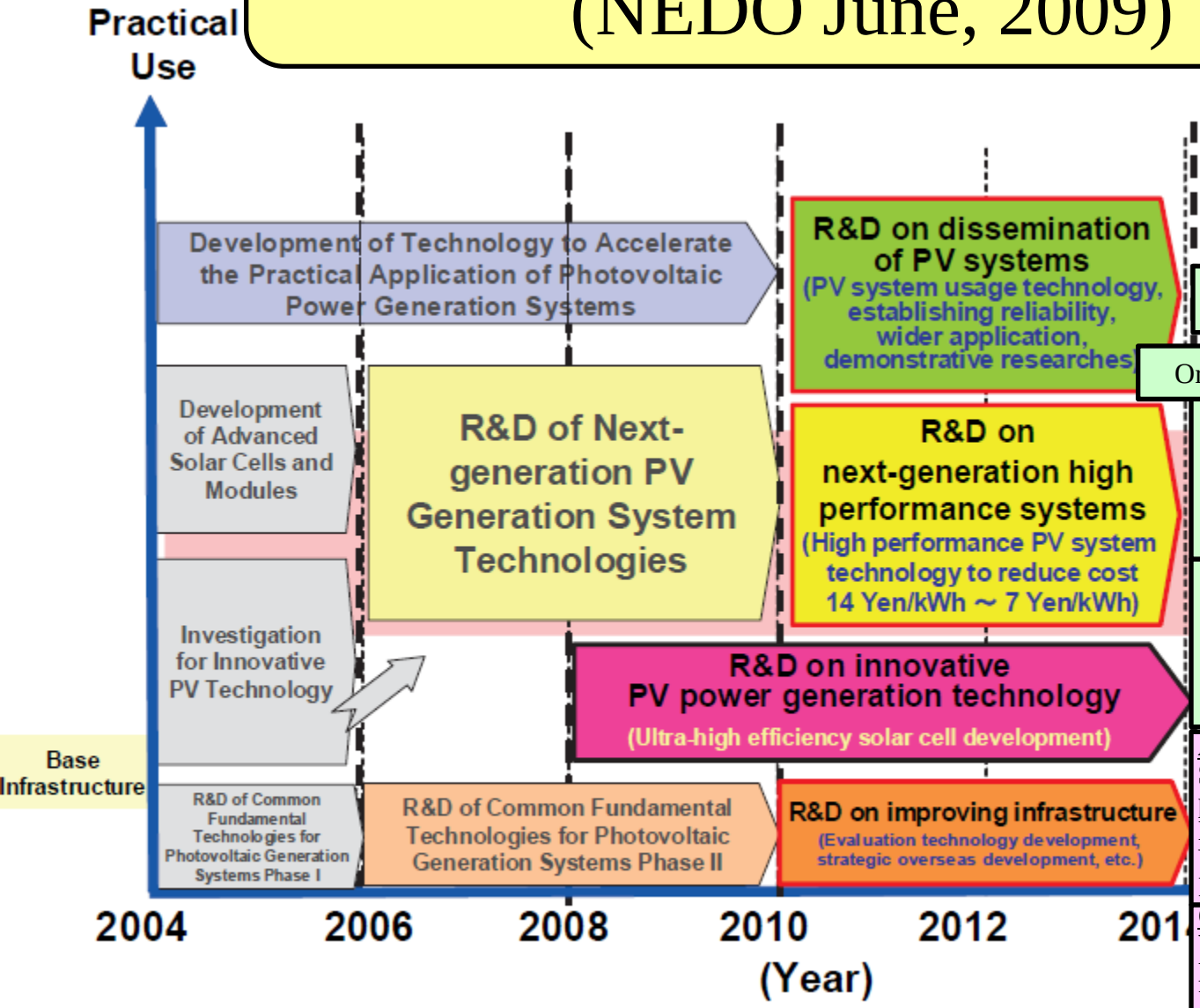


Figure 6 Overview of immediate technology development projects

Subsidy: Private house
FY 2012: 400$/kW, ca.500M$

Organic solar cell: 2012- FY2012 25M$ 2/3

2010-2014
C-Si, TF-Si
CIS, DSC
FY2012 75M$

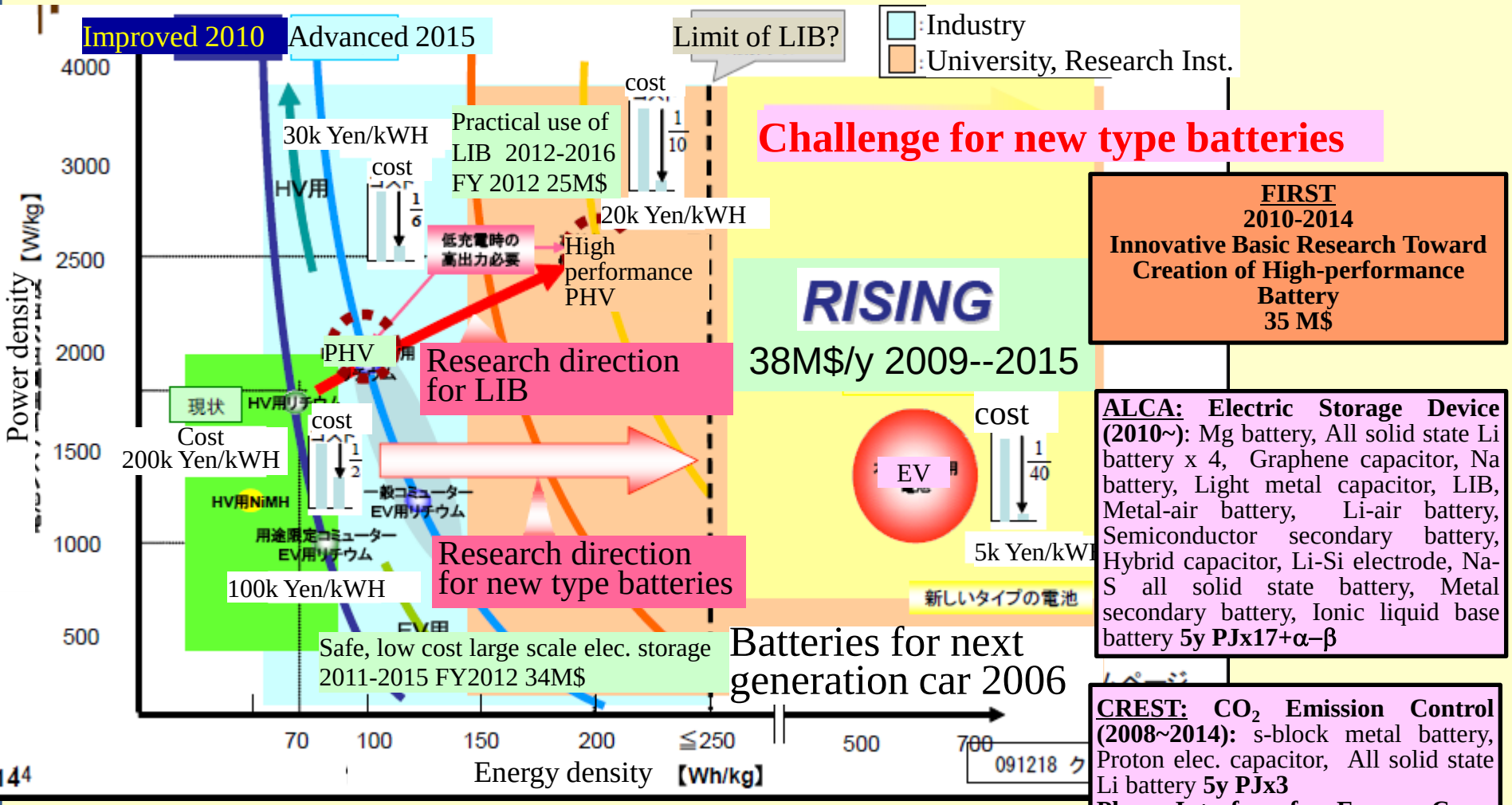
2008-2014
Post Si (tandem, QD, etc)
Highly ordered TF multi junction
FY 2012 30M$

FIRST
2010-2014
OPV toward a Low-Carbon Society
37 M$

ALCA: Solar Cell and Solar Energy System (2010~): NP, Nanostructure/c-Si, paintable OTF, Si clathtrate, Group IV TF Multi-Layered, Nano C, DSC, Liq. Si, III-V-N, hybrid C, $Cu_2ZnSn(S,Se)_4$ TF, Si/Ge, InGaN: **5y PJx14+α–β**

CREST: Clean Energy Generation Using Solar Energy (2009~2015): a-Si, DSC, OTF, exciton, CZTS tandem, InN/Si, Cat-CVD, Si prod., photonic nanostructure, hetero-junction : 5y/PJx14: **CO_2 Emission Control (2008~2014):** OPV **5y PJx1**

Electrical Energy Storage



FIRST
2010-2014
Innovative Basic Research Toward Creation of High-performance Battery
35 M$

ALCA: Electric Storage Device (2010~): Mg battery, All solid state Li battery x 4, Graphene capacitor, Na battery, Light metal capacitor, LIB, Metal-air battery, Li-air battery, Semiconductor secondary battery, Hybrid capacitor, Li-Si electrode, Na-S all solid state battery, Metal secondary battery, Ionic liquid base battery **5y PJx17+α–β**

CREST: CO_2 Emission Control (2008~2014): s-block metal battery, Proton elec. capacitor, All solid state Li battery **5y PJx3**
Phase Interface for Energy Conv. (2011-2017): none

Fuel Cell and Hydrogen

Hydrogen

Hydrogen distribution infrastructure 2011-2015 **FY2012 40M$**

Hydrogen production/ transportation/ storage 2008-2012 **FY2012 19M$**

Hydrogen fundamental science 2008-2012 **FY2012 10M$**

CREST: Clean Energy Generation Using Solar Energy (2009~2015): Photocatalytic decompo-sition of water : **5y PJx1**

ALCA: Solar Cell and Solar Energy System (2010~): Photocatalytic decompo-sition of water, **5y PJx1+α–β**

High temp.
1000 C
SOFC

SOFC system components 2008-2012 FY2012 8M$

ALCA: Electric Storage Device (2010~):SOFC/SOE , **5y PJx1+α–β**

CREST: Phase Interface (2011~): Interface eng. for SOFC , Multiscale anal. for SOFC **5y PJx3+α**
CO_2 Emission Control (2008~2014): All solid state alkaline FC **5y PJx1**

PEMFC practical application 2010-2014 **FY2012 44M$** Two major centers (Yamanashi Univ., FC-Cubic) + PJs (low Pt, carbon alloy, oxide)

PEM
100 C
Low temp.

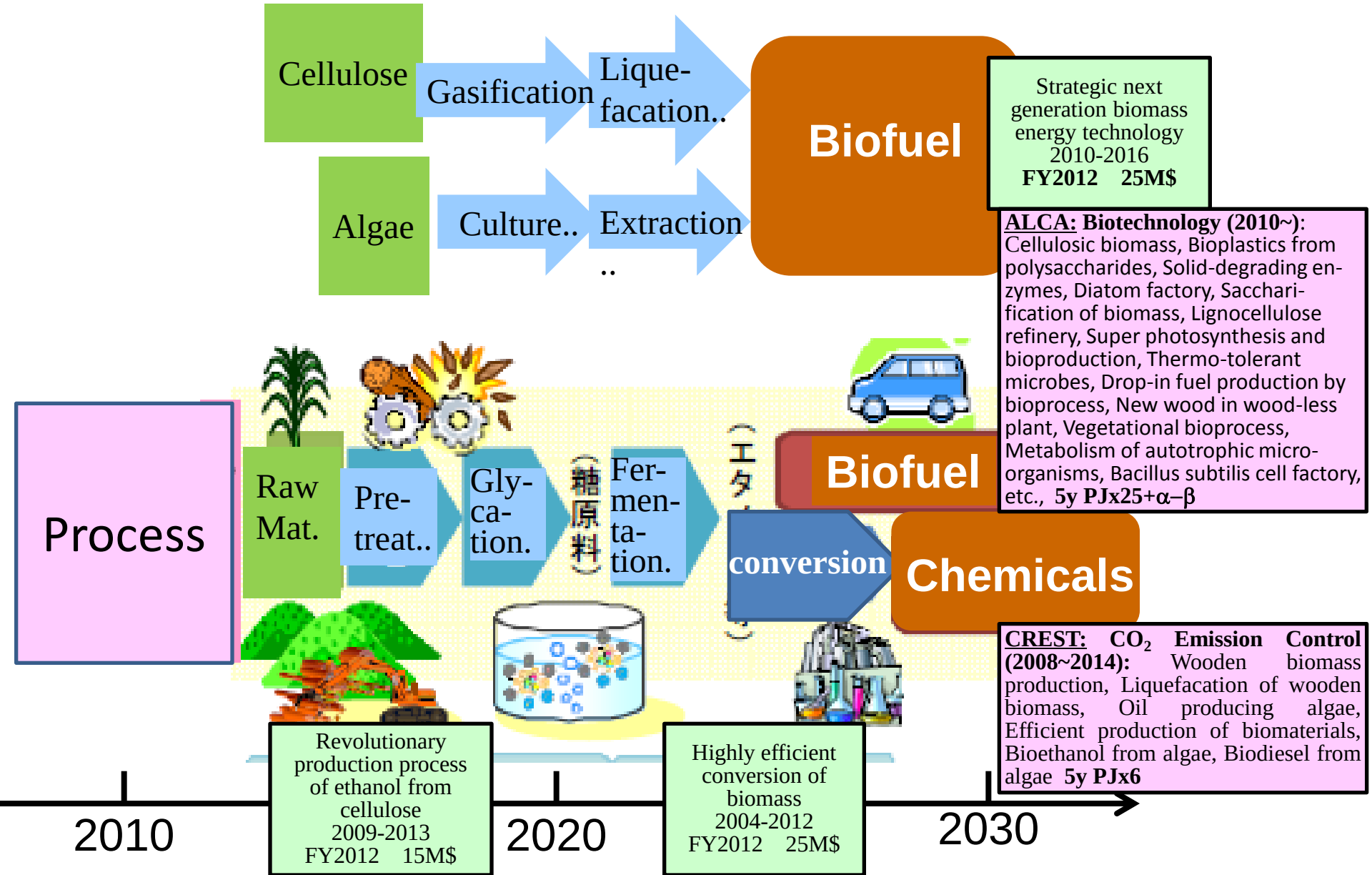
CREST: CO_2 Emission Control (2008~2014): All solid state alkaline FC **5y PJx1**

ALCA: Electric Storage Device (2010~): Carbon alloy catalyst, Liq. fuel FC **5y PJx2+α–β**

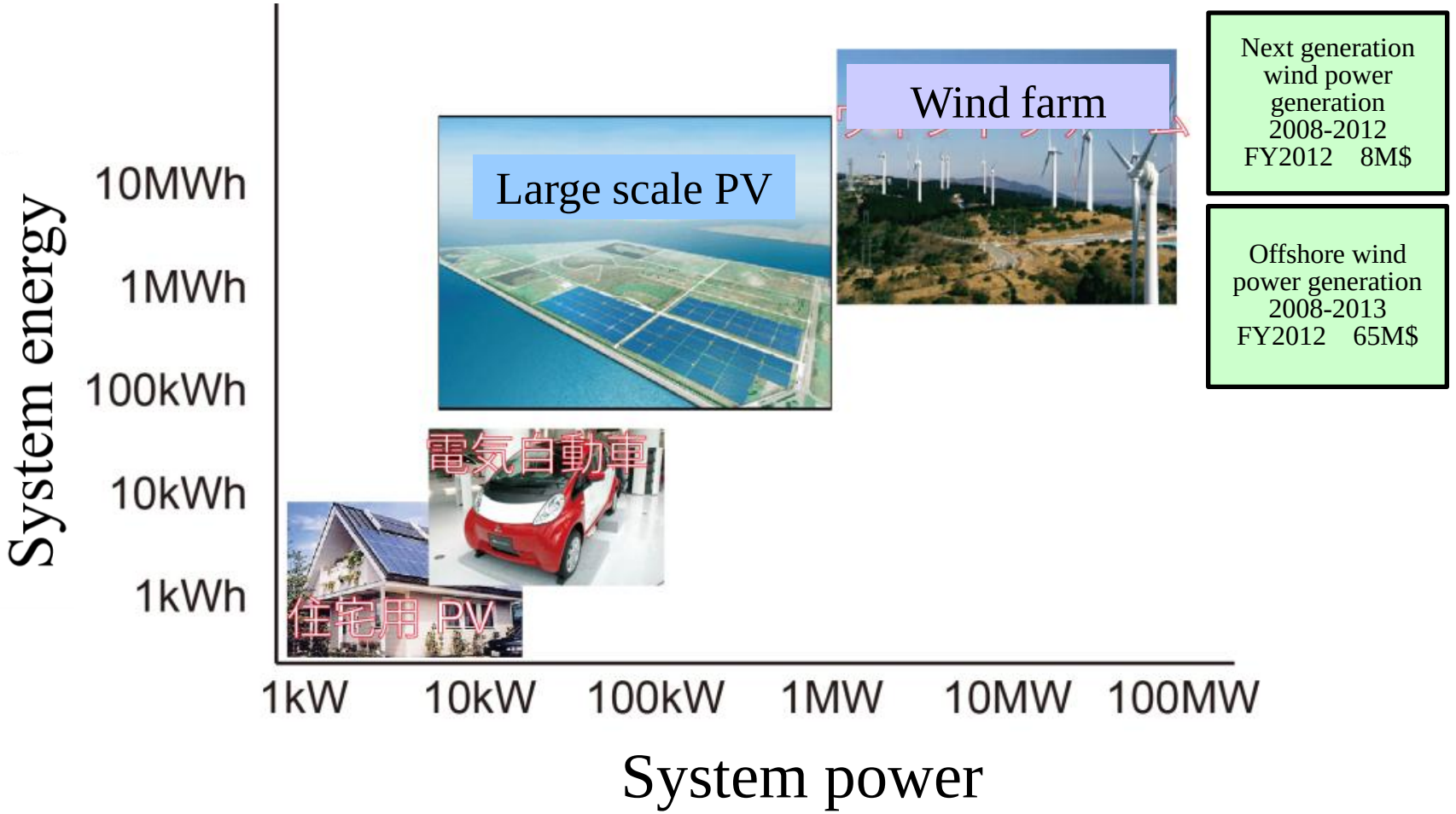
Subsidy: Private house
FY 2012: 50% hot water supply 110M+60M$

WPI
International Institute for Carbon-Neutral Energy Research
2010 - 2019 (+ 5 years) 18M$/y

Biomass


Cellulose
Gasification
Lique-facation..
Algae
Culture..
Extraction ..
Biofuel
Strategic next generation biomass energy technology 2010-2016
FY2012 25M$
ALCA: Biotechnology (2010~): Cellulosic biomass, Bioplastics from polysaccharides, Solid-degrading enzymes, Diatom factory, Saccharification of biomass, Lignocellulose refinery, Super photosynthesis and bioproduction, Thermo-tolerant microbes, Drop-in fuel production by bioprocess, New wood in wood-less plant, Vegetational bioprocess, Metabolism of autotrophic micro-organisms, Bacillus subtilis cell factory, etc., 5y PJx25+α–β
Process
Raw Mat.
Pre-treat..
Gly-ca-tion.
糖原料
Fer-men-ta-tion.
エタノール
Biofuel
conversion
Chemicals
CREST: CO2 Emission Control (2008~2014): Wooden biomass production, Liquefacation of wooden biomass, Oil producing algae, Efficient production of biomaterials, Bioethanol from algae, Biodiesel from algae 5y PJx6
Revolutionary production process of ethanol from cellulose
2009-2013
FY2012 15M$
Highly efficient conversion of biomass
2004-2012
FY2012 25M$
2010
2020
2030

Wind Power



Next generation wind power generation
2008-2012
FY2012 8M$

Offshore wind power generation
2008-2013
FY2012 65M$

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•Energy	Photovoltaic and solar thermal 130M$ 22M$	Wind 73M$
	Biomass 65M$ 15M$	Geothermal and hydraulic
	Fuel cells and hydrogen 121M$ 25M$	Energy conservation
	Smart community	Electricity storage 97M$, 16M$
	Field tests	Introduction and Discussion
	Coal resource development	
•Environment	3R (Reduce, Reuse, Recycle)/Water recycling	HFC, PFC, and SF6 measures
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MEXT Program for Development of Environmental Technology Using Nanotechnology (2009-2018 FY2012: 5M$)

GREEN

Global Research Center for Environment and Energy based on Nanomaterials Science (GREEN)

Targets

Targets

Solar cell

Secondary battery

Photocatalyst

Fuel cell

Computer simulation
Electron and atom dynamics analysis
Electron transfer, Ion diffusion

To solve common problems in energy flow starting from solar energy

Understanding and control of interfacial phenomena
Collaboration and fusion of theory and experiment

Cutting edge measurement
In situ measurement of surface/interface
Real environment, solid/liquid interface

Dream team

Industry

Universities and Research Institutes

World Premier International (WPI) Research Center Initiative

～To create top world - level Research hubs in Japan

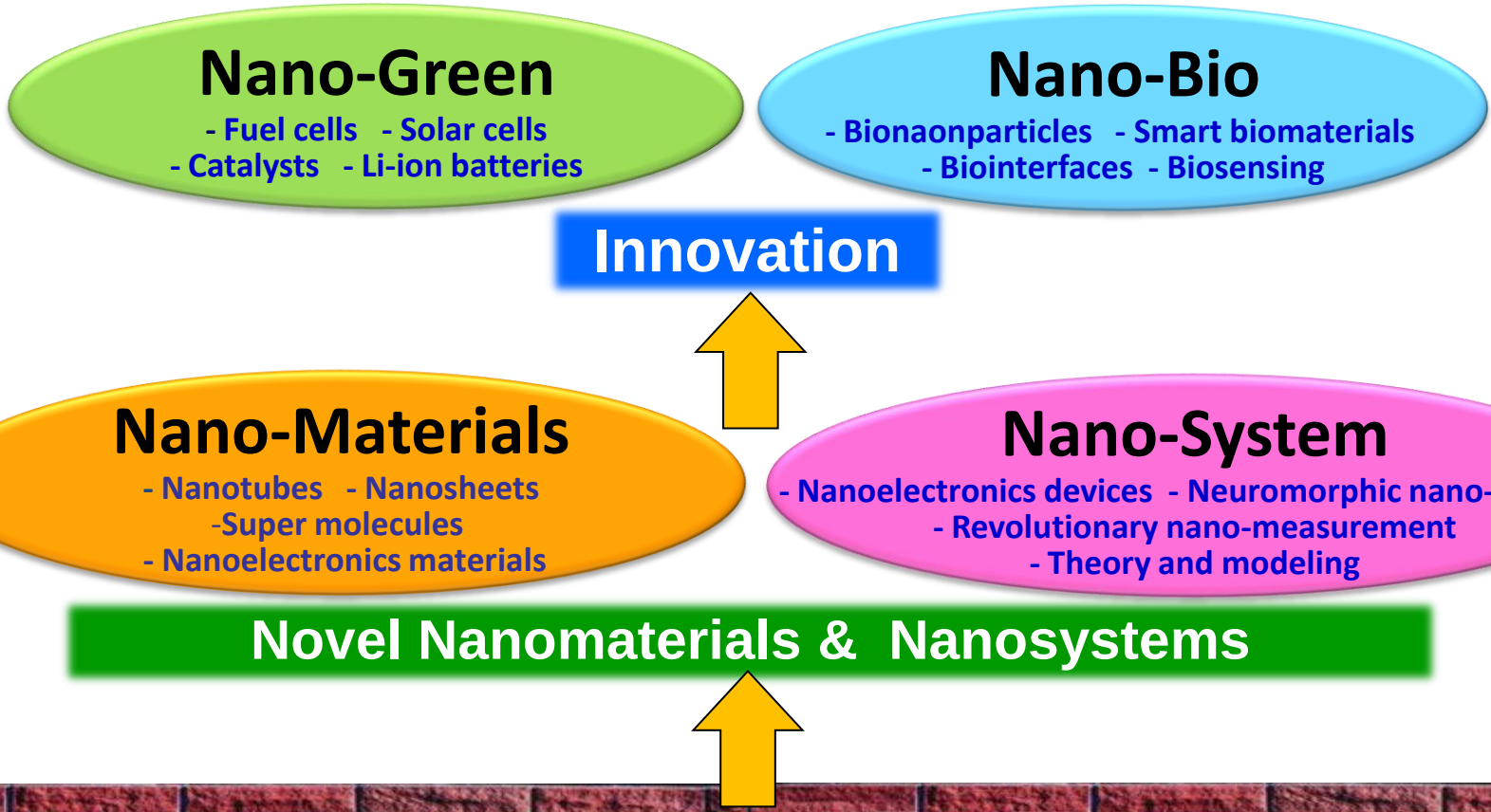
1. **Top Quality of Science**
2. **Achievement of Breakthrough by Fusion Researches**
3. **Globally Visible Research Center**
4. **Break of Administrative Limitation**

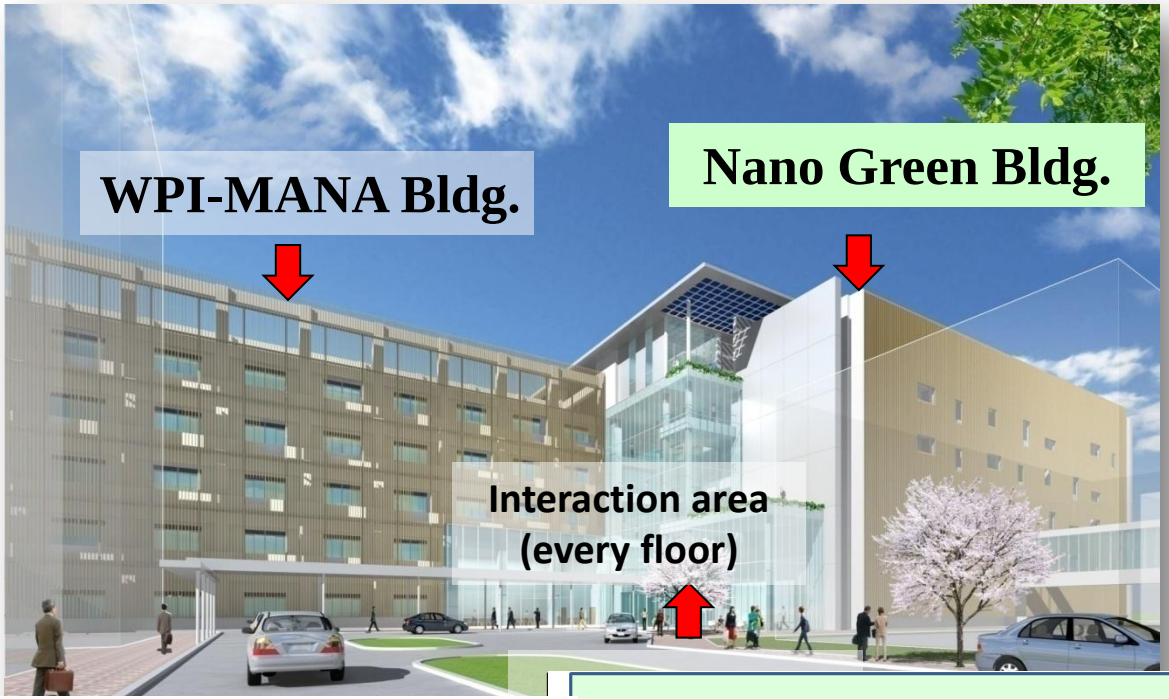
Selected Organizations & Projects (2007.10)

◆NIMS	Nanotechnology ·Materials
◆Univ. Tokyo	Astrophysics
◆Kyoto Univ.	Stem Cells
◆Tohoku Univ.	Materials Science
◆Osaka Univ.	Immunology
◆Kyusyu Univ.	Carbon-Neutral Energy (2011.10)

- ✓ **Period: 10 to 15 years**
- ✓ **Funding: 1.4B JPY (~~14M~~ 18M US$) a year per center**
- ✓ **Matching fund scheme:**
  Each center has to earn the same amount of research funding

Research organization of MANA





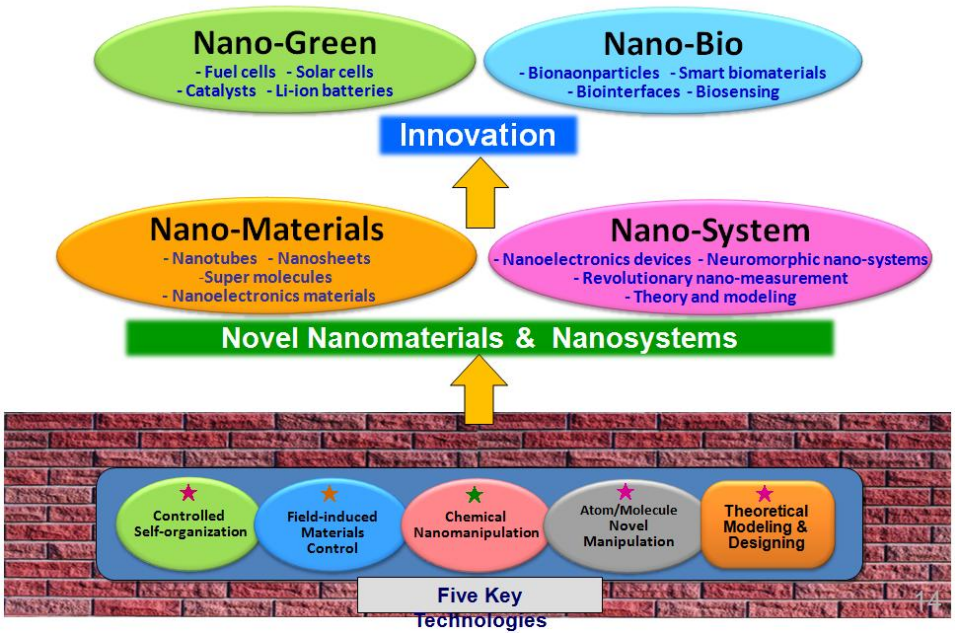
13,500 m^2

90 M$

Supplementary budget ,2009

Completed March 2012

Research organization of MANA



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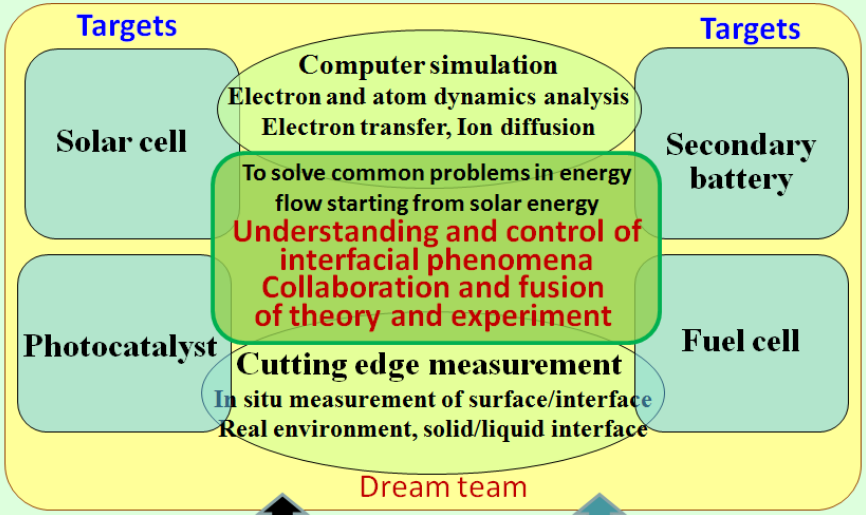
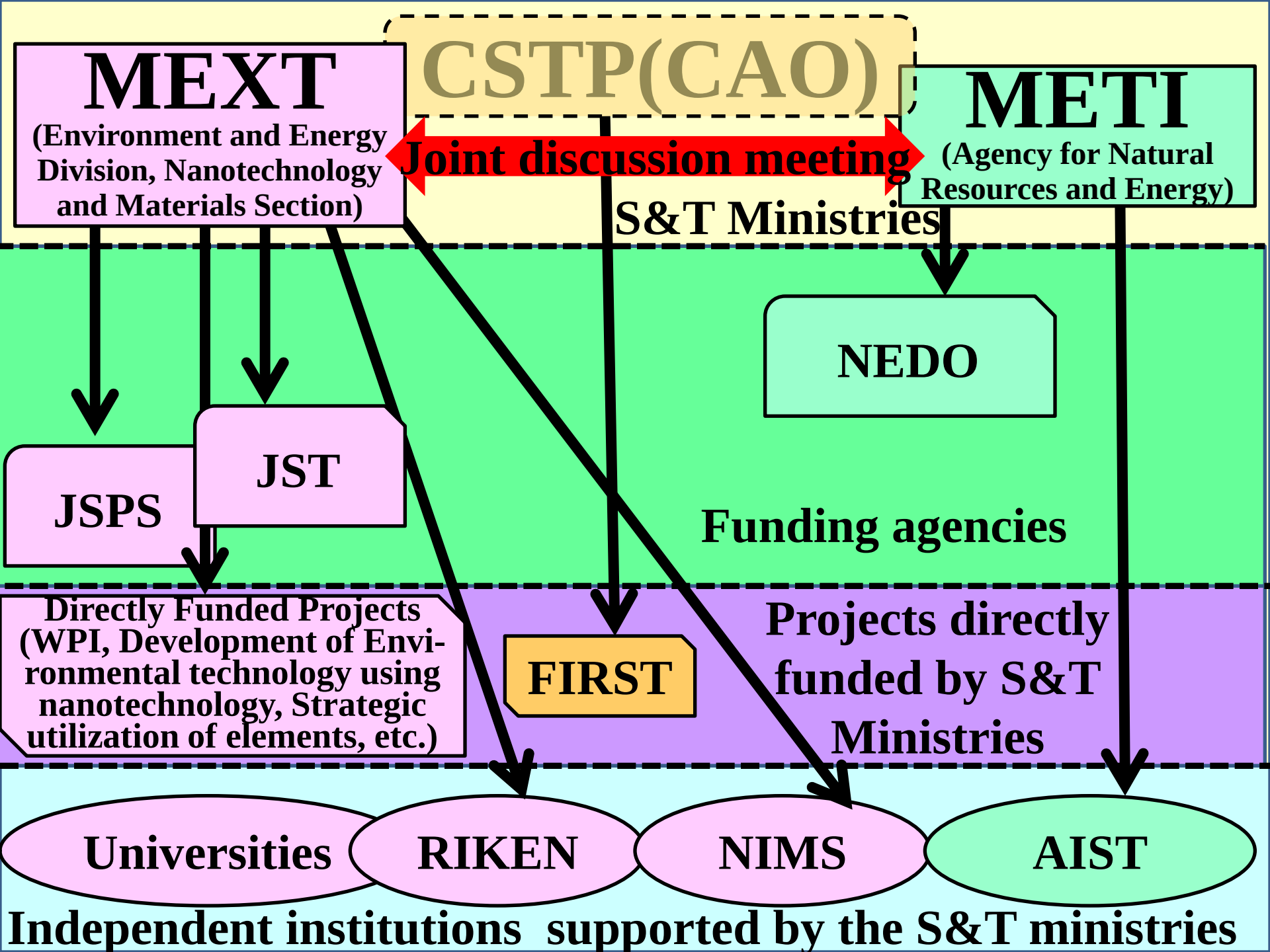


MEXT program 2009-2018 FY2012 5M$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