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Strategic Planning of Energy-related Research and Development

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Argument by Professor Peter Taylor

- Reassessment of our approach to energy technology innovation, including research, development and demonstration (RD&D)
- Mismatch between the allocation of RD&D funding and the technologies needed to address global energy challenges
  - More emphasis on distributed supply technologies and energy efficiency
- Technology policies towards a more integrated approach, stimulating both the development and deployment of clean technologies
- Japan as a leader working with other Asian nations to drive forward successful energy innovation to meet global energy challenges

Japan's Current Concerns

World Trend

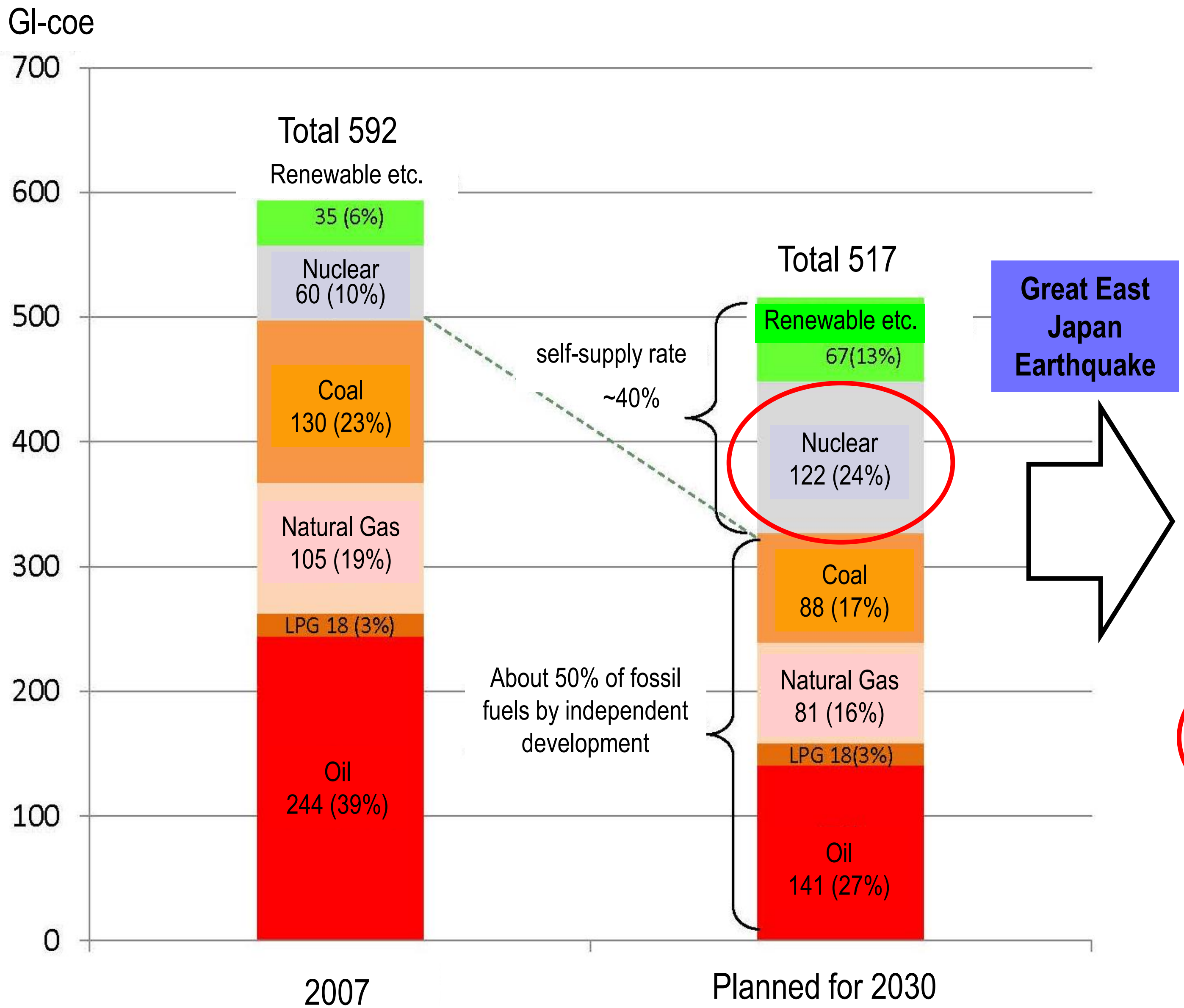
1. Fossil fuels to be primary feedstock for the next several decades
2. Nuclear power as a major electricity supplier with its safety continuously improved
3. Massive introduction of renewable energy sources with better performance, reduced cost and improved stability

Japan's Concerns

1. Decreasing self-sufficiency of energy
2. Trade deficit due to soaring prices of fossil fuels and increased imports
3. No definite pathway to achieve Japan's pledge for GHG emission reduction goals in 2020 or 2030
4. Excessively high purchase prices in the FIT to be inevitably revised in the near future
5. Rapid spread of low-price imported photovoltaic panels into Japanese market while domestic suppliers declining

Redesigning "Basic Energy Plan"

Primary Energy Breakdown in 2030



New energy plan options for 2030 with nuclear power fractions of:

a. 0 %
b. 5 %
c. 20~25 %

and renewables of 25~35%

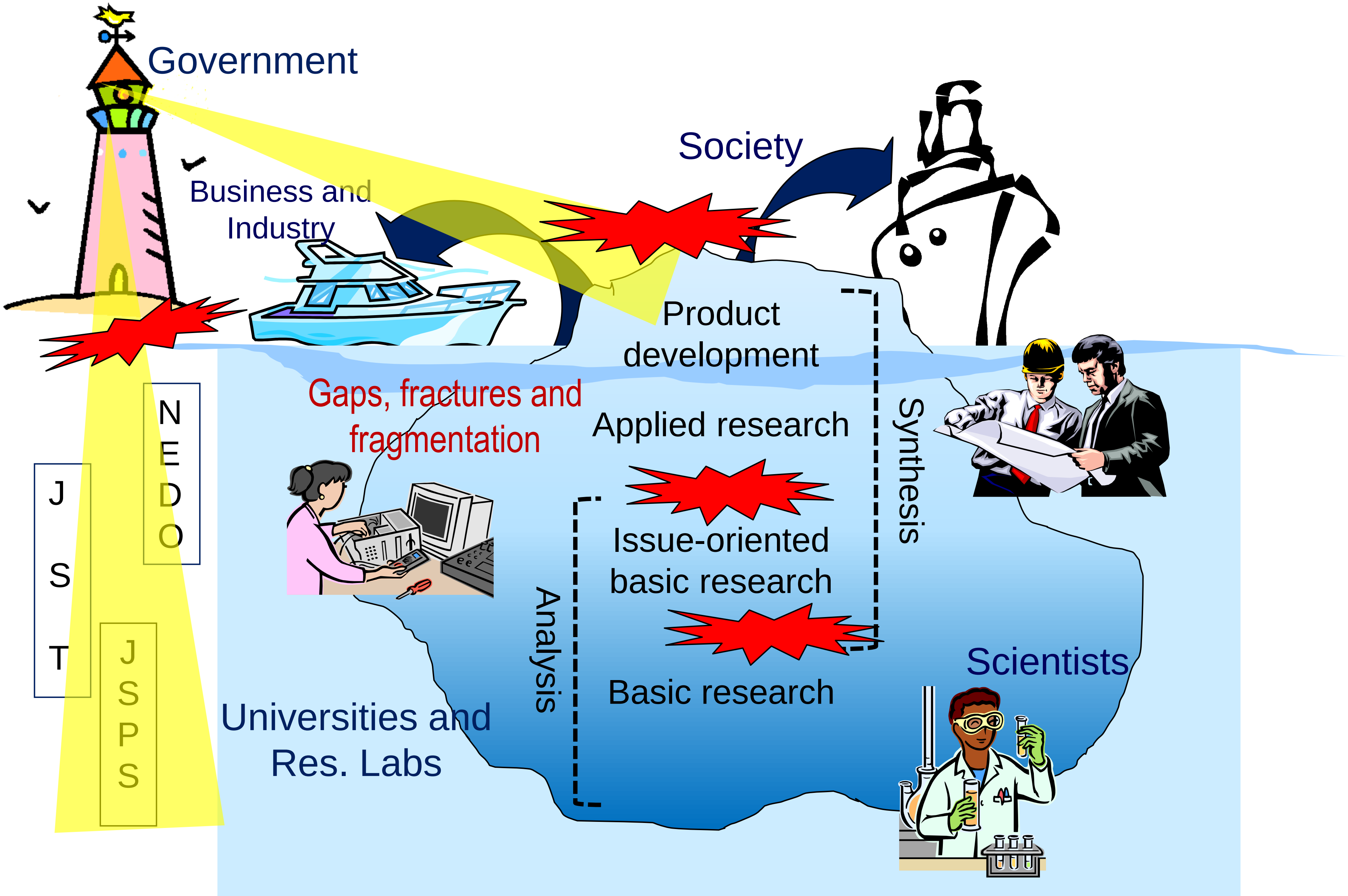
Consolidated Policy Approach for Green Innovation

- “Direct Funding” for basic, applied and development research, research infrastructures, and human resources
- “Indirect Funding” for IP promotion, R&D tax reduction, deregulation, market opening, standards, business internationalization

  Ex. High-performance small-scale power generators, such as gas engines, micro gas turbines, wind turbines, solar panels and fuel cells, were developed in the 1990’s, but not introduced to the electric power market, which was occupied by the major monopolizing companies. It was only in the 2000’s that the market was opened partially.

- Identification and documentation of target technologies and implementation of PDCA cycle

R&D System for Innovation

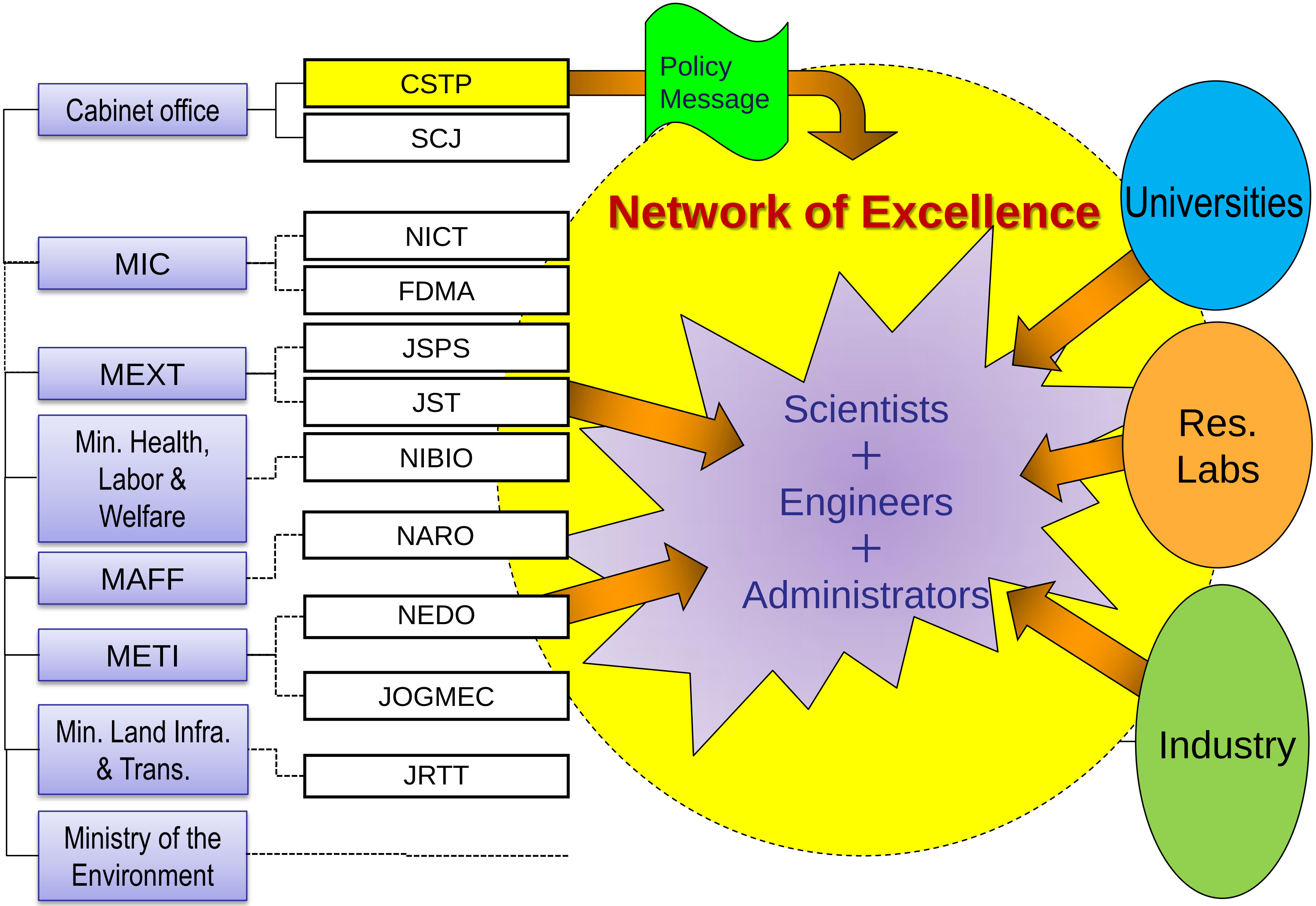


Gaps to be Filled

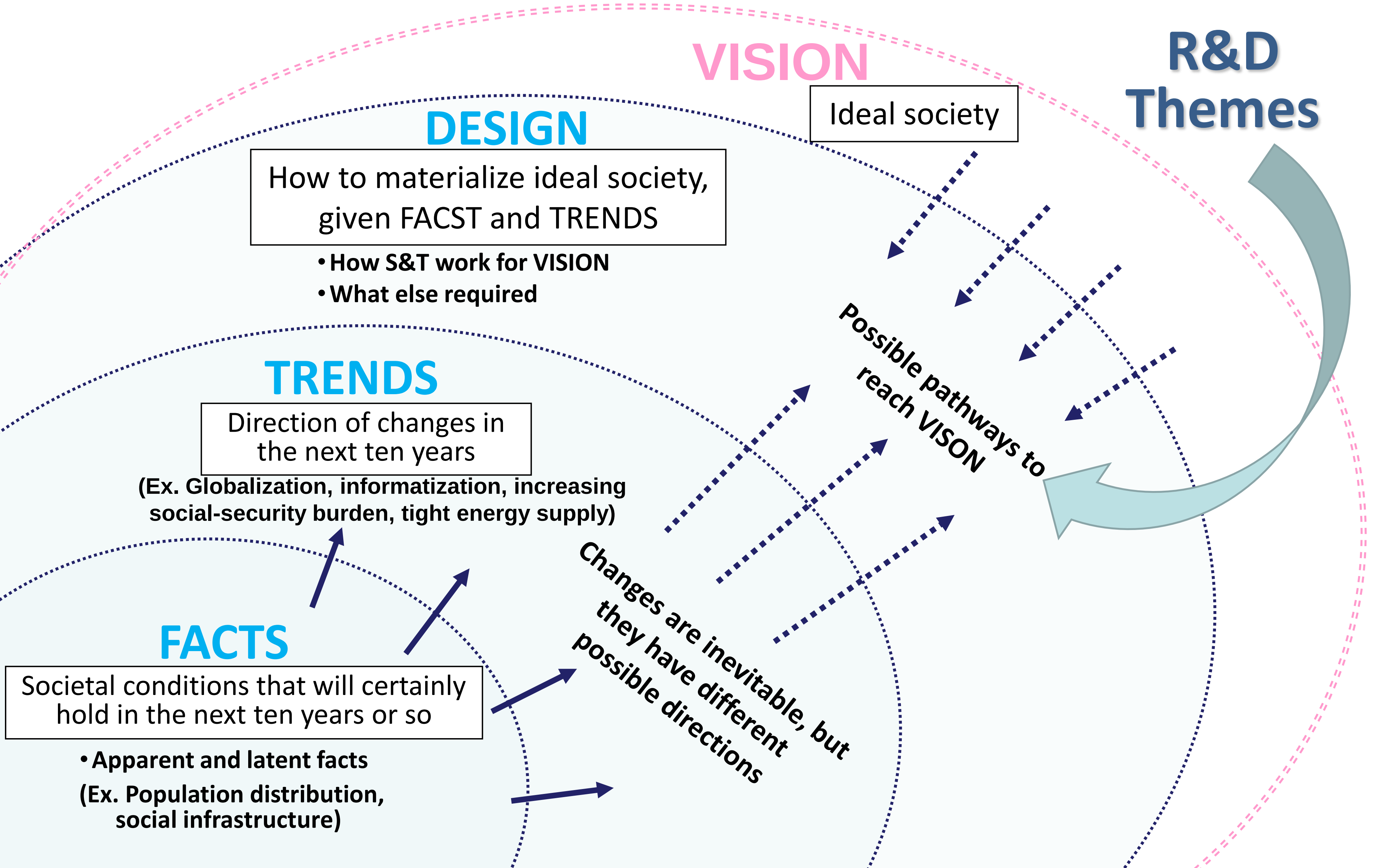
Between:

- Basic and applied research
- Scientific disciplines
- Industry/business, research laboratories and universities
- Government ministries and funding agencies
- Scientists/engineers/administrators and society

Consolidated Funding Schemes



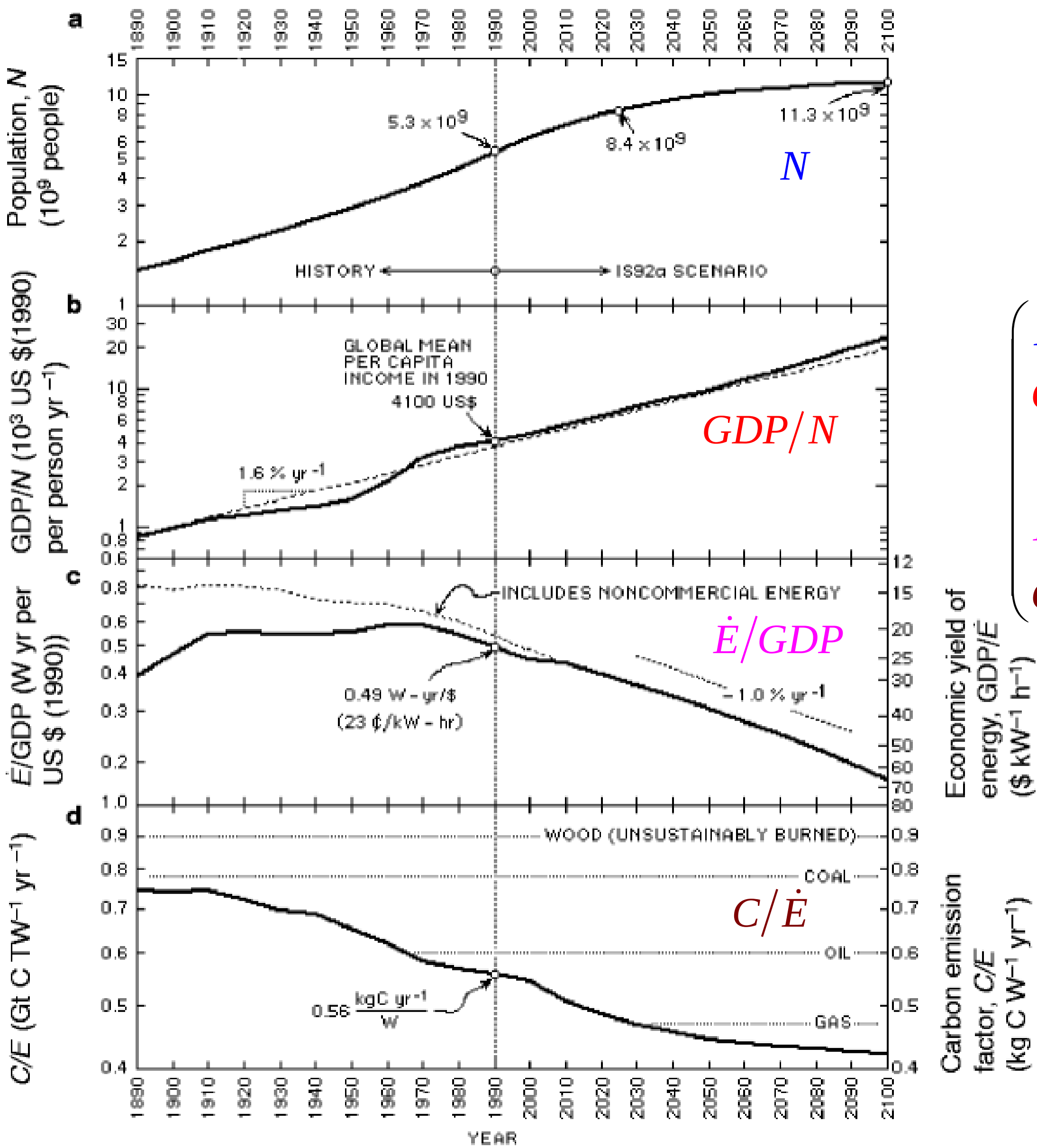
Identifying Technology Goals to Meet Social Wishes



Basic Strategy for Energy and Environmental Research

1. Focus on 3E+ (energy, environment, economy, ethics)
2. Short-, mid- and long-term R&D goals
3. Basic scientific rules and principles of energy utilization under the constraints of environment and resources
4. Cross discipline collaboration based on a shared perspective view
5. Network of excellence (cf. COE) and collaboration between industry, academia and government with participation of younger researchers

GHG Emission Prospect Based on Identity Equation



N: population

GDP/N: per capita gross domestic product ($/yr)

$\dot{E}/GDP$: primary energy intensity (Wyr/$)

$C/\dot{E}$: carbon intensity (kgC/Wyr)

(Hoffert, M.I. et al., Nature, 1998)

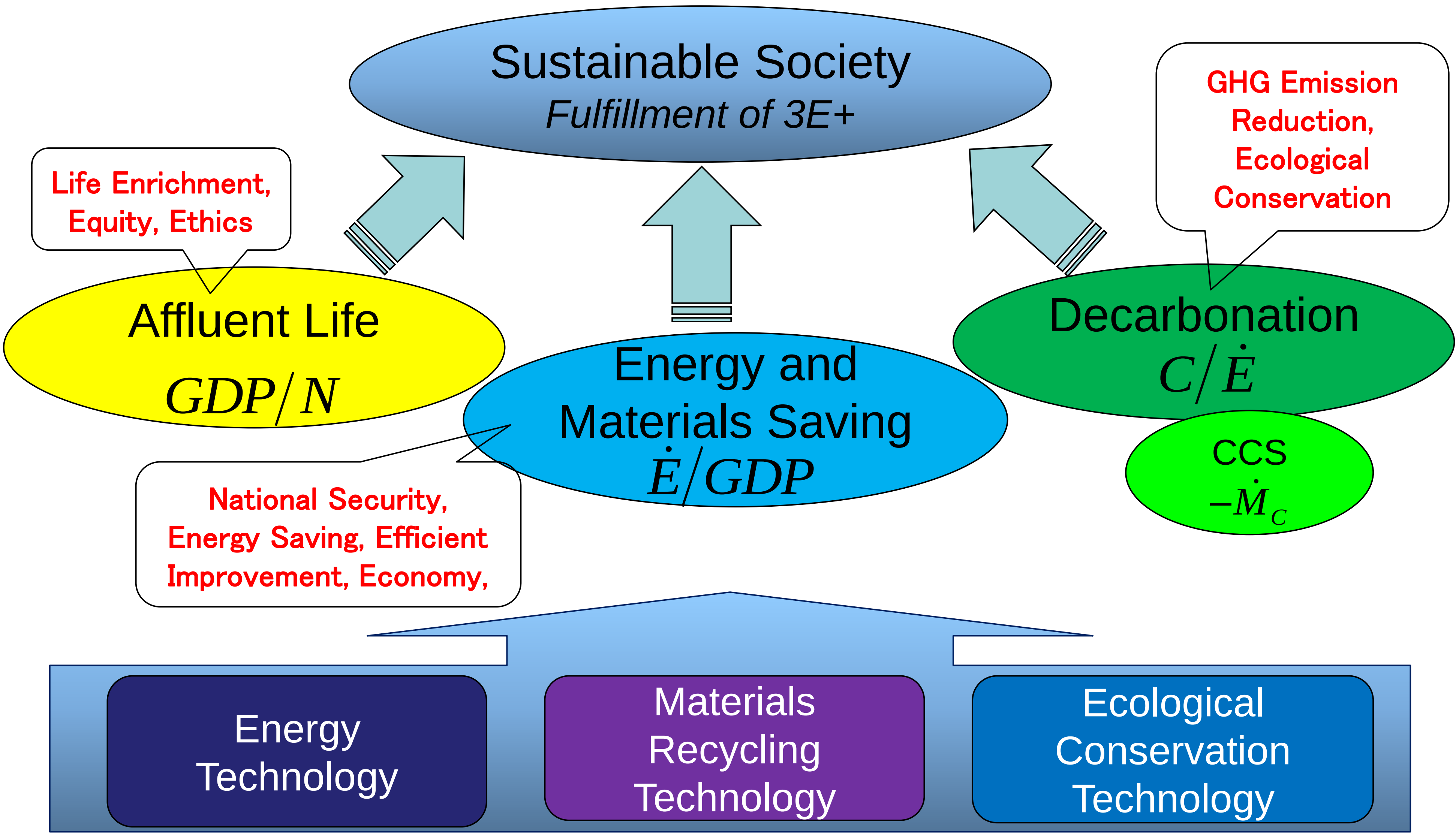
Basic Principle for CO_2 Emission Reduction

$\dot{E}/GDP$: primary energy intensity (Wyr/$)

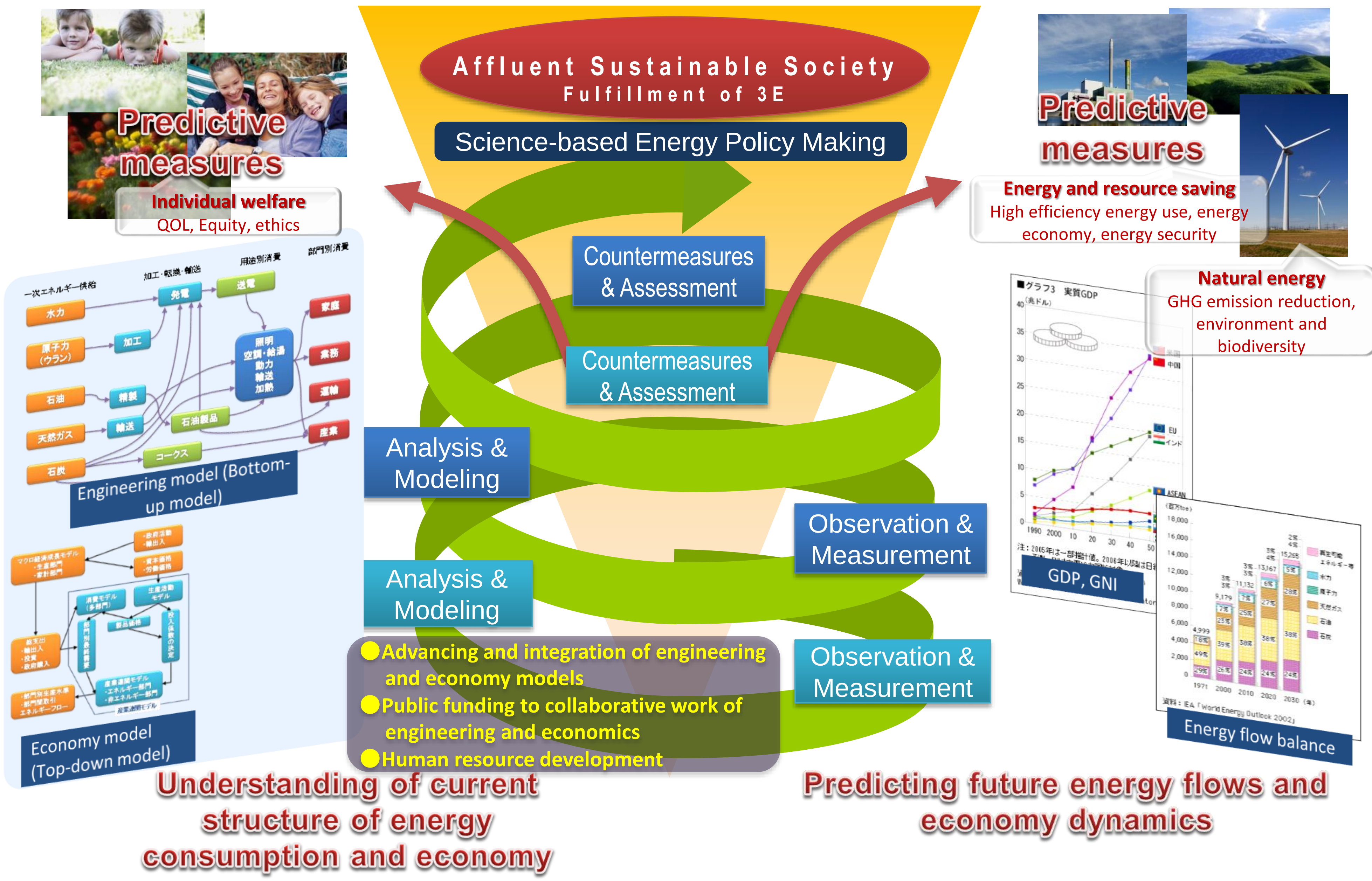
- Energy saving
- Efficient energy utilization
- Industrial renovation, material recycling
- Added value, cost effectiveness
- Life style, values

- Decarbonation, reduction of fossil fuel use
- Fuel reform, carbon sequestration
- Renewable energy
- Nuclear power
- New energy resources

STI for Society and the Environment



Science for Energy Policy: R&D on Engineering and Economy Models

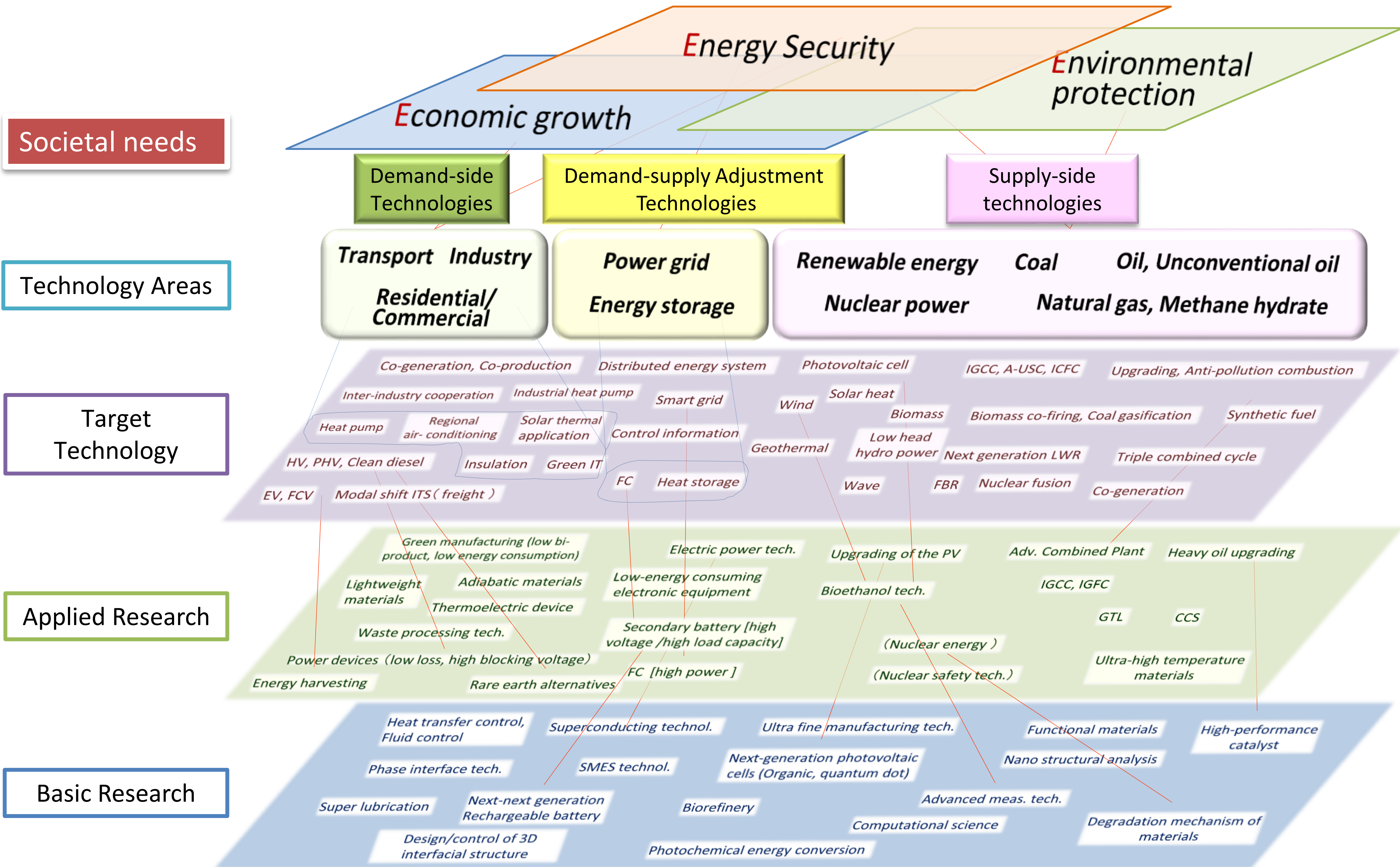


Strategic Planning of R&D on Advanced Energy Technologies

1. Relevance of Energy Technologies

- Linking science to innovation, economic growth and social welfare
- Common wish to fulfill requirement of "*stable, safe and sustainable energy supply with least cost*"
- Contexts of national security and industrial/economic competitiveness at the nation's level
- Assessment of energy technology options from three viewpoints of 3E+

Perspective View of Social Wishes, Target Technologies and Scientific Research



Strategic Planning of R&D on Advanced Energy Technologies

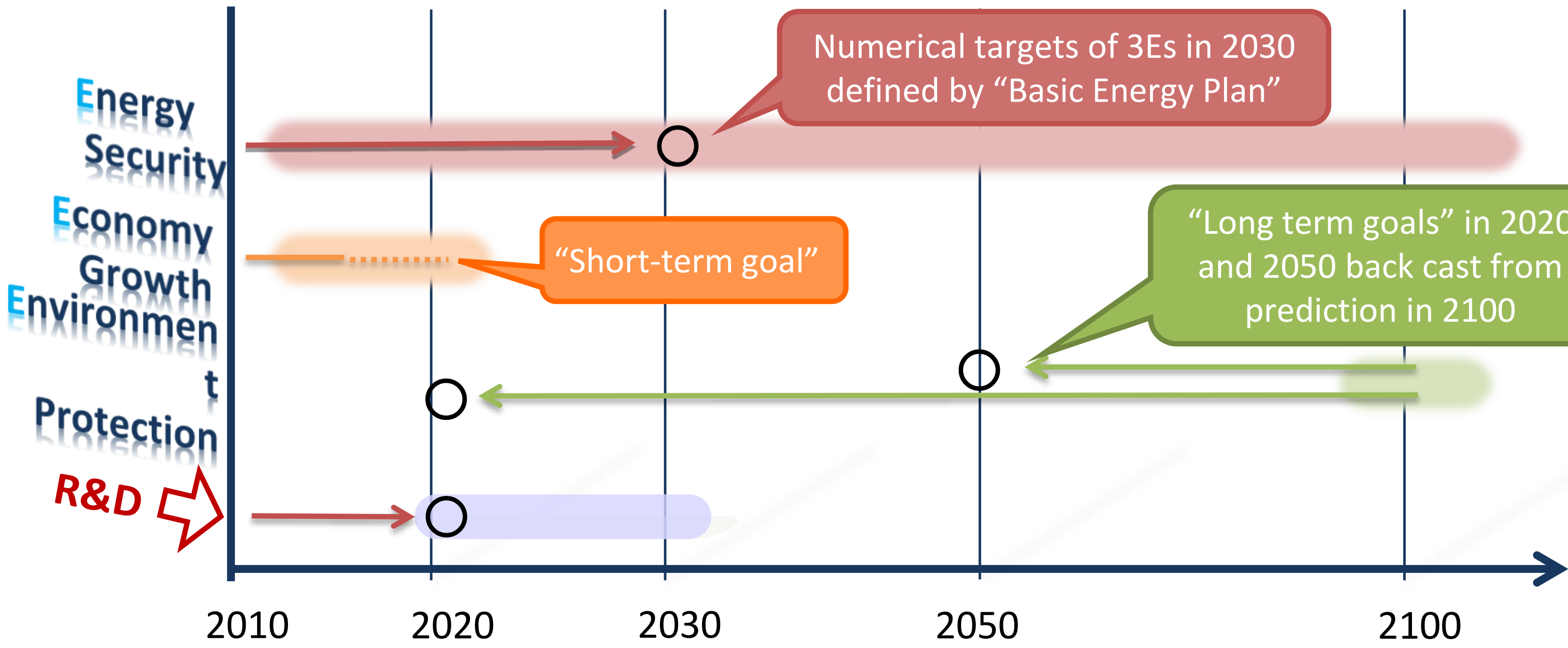
2. Structuring Focal Areas and Research Themes

- Hierarchical structures with different layers of societal needs, target technologies, scientific research and scientific disciplines
- Upper layer R&D more relevant to societal issues (Needs-pull)
- Lower layer R&D driven by technology breakthrough and basic science (Seeds-push)
- Scientific breakthroughs connected to innovative technologies and social needs in many possible ways

Strategic Planning of R&D on Advanced Energy Technologies

3. Time Axes

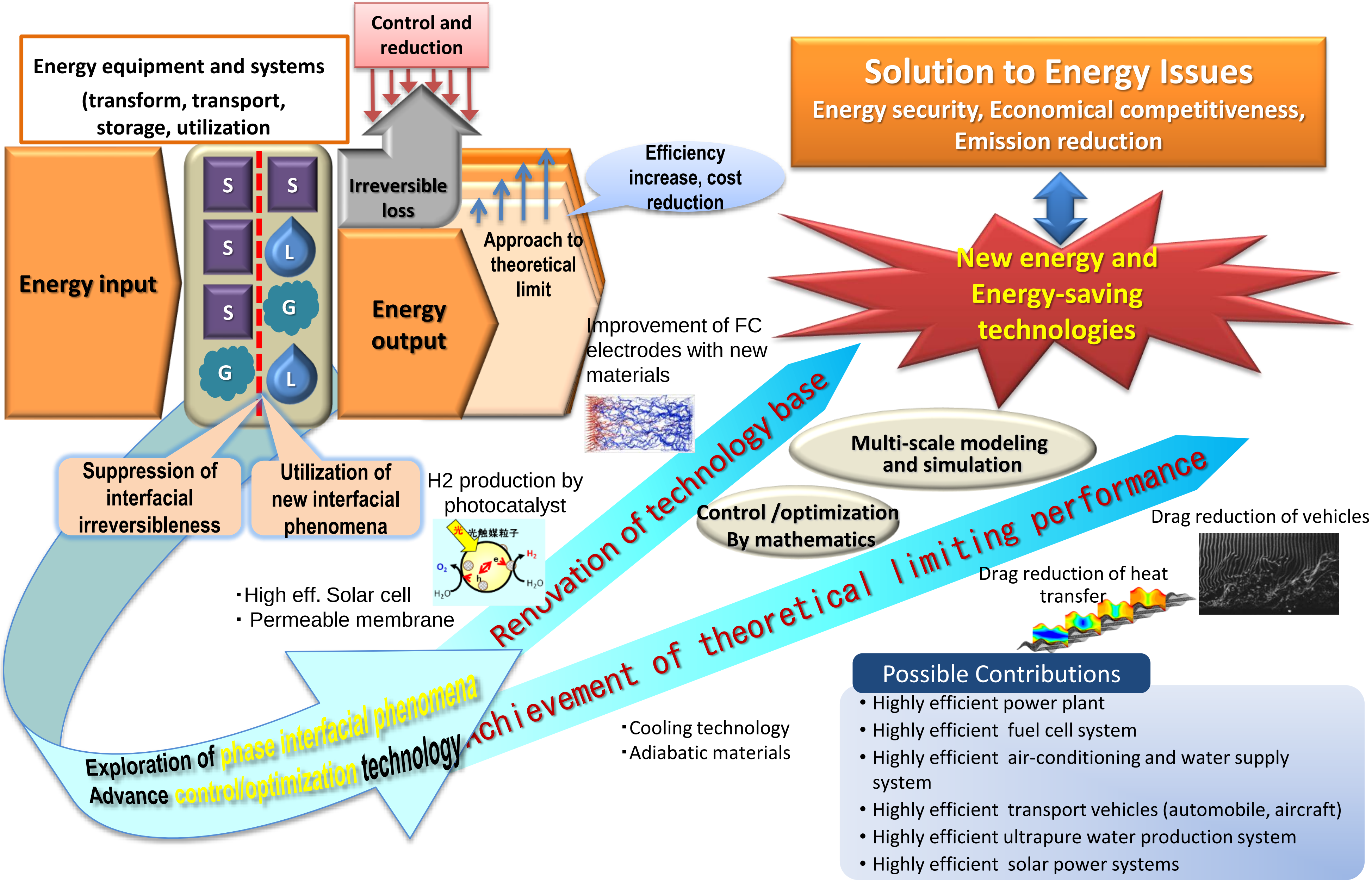
- Time scale of R&D dependent on assessment indices
- Timely technology identification, optimal target time setting, R&D policy consistent over 10 to 20 years



Assessment Indices for Technology Options

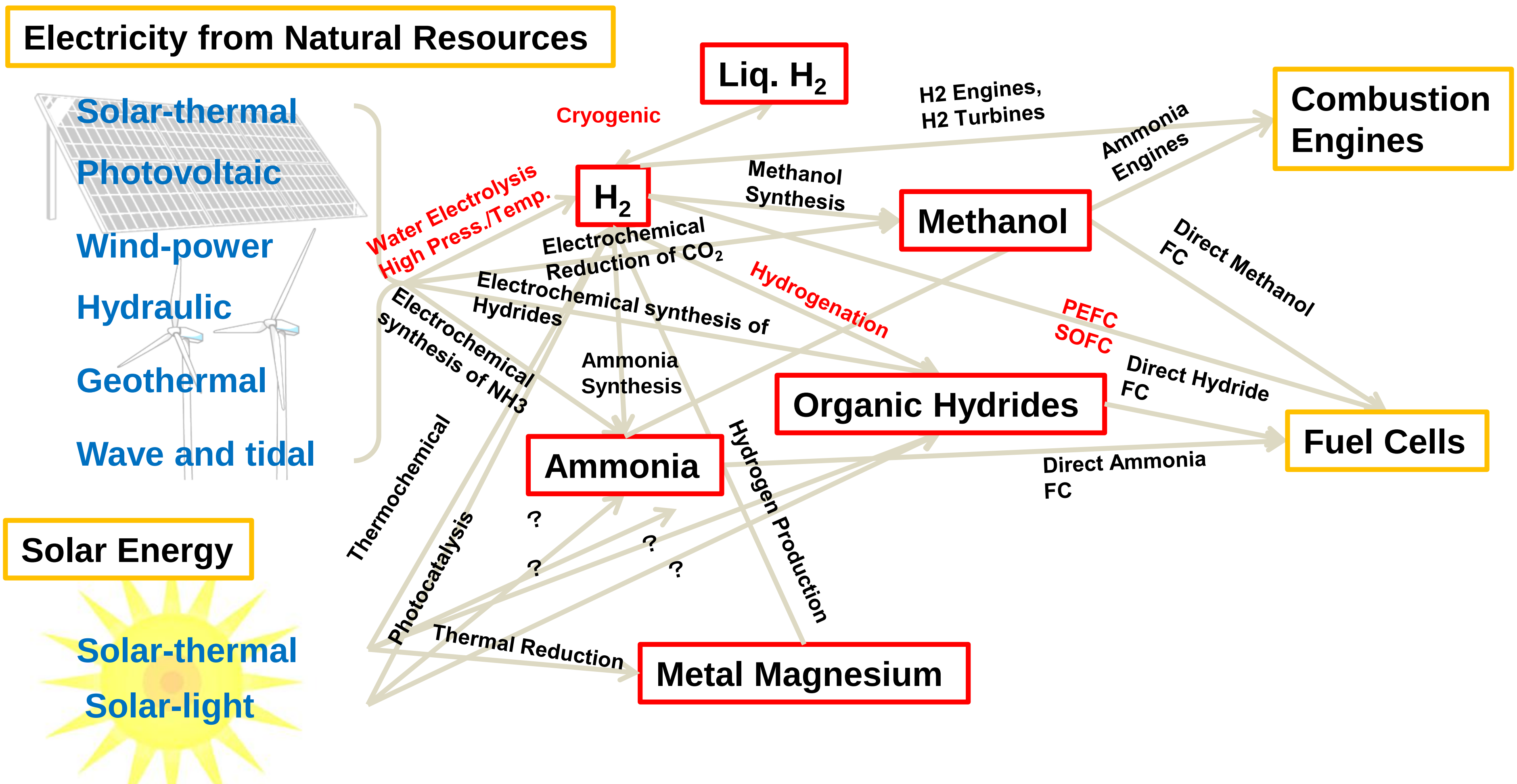
Energy Security	Environment (Safety)	Economy (Cost)
• Resource reserve (geophysical/geopolitical distribution), Reserve-production ratio (fossil and nuclear fuels) • Security and stability of resource feedstock (import dependence, independent development) • Stability of international market fuel price • Time-dependent fluctuation, rates of availability and operation (natural energy resources) • Rate of plant operation (periods of inspection and repair) • Response to load fluctuations • Disaster countermeasures and energy supply to isolated areas	• Climate change (GHG) • Radioactive wastes, radioactive contamination (nuclear power) • Atmospheric contamination (NOx, SOx, soot, particulates), Ozone layer destruction (CFC), thermal discharge • Compatibility to food production, Condensation of specific molecules (N, P) (biomass, biofuels) • Impacts on ecology and biodiversity	• LCA, energy profit ratio, energy payback time • Fuel costs (mining, transformation, transportation, storage), material cost, energy price, electric power price • Business continuity stability against fuel price fluctuation • Costs for R&D, equipment, plant construction, land, installation, environmental countermeasures • Length of periods for environmental assessment and construction • Costs for maintenance, waste processing, decommissioning • Costs for countermeasures to terrorism and disaster, recovery cost and time, compensation • Economical impact as energy industry (energy equipment, electric power market, fuel businesses), employment

Phase Interface Science for Energy Efficient Society



Renewable Energy Carriers for Transportations, Storages, and Utilizations

1. For international and intercontinental transportations
2. For leveling of natural energy in local regions
3. For house energy systems



Thermal Energy Utilization