

**STI2022 Conference**

*Project-based funding for green energy  
technology by the Korean Green Mission  
and its changes and characteristics*

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# Green missions and initiatives



Picture:

Upstream, "‘Much to build, much to change’: Biden era begins, oil players strategise" (20 Jan 2021)

# Rise of mission-oriented innovation

- “Mission” as a systemic intervention to address societal challenges
  - Coordinated package of research and innovation policy measures to contribute societal goals
  - Orientate public interventions and collective efforts crossing various policy fields
- Influence of mission on research prioritization
  - Mission calls to mobilize science, technology and innovation
  - Shift in STI policy towards societal impact and contributions of research to society

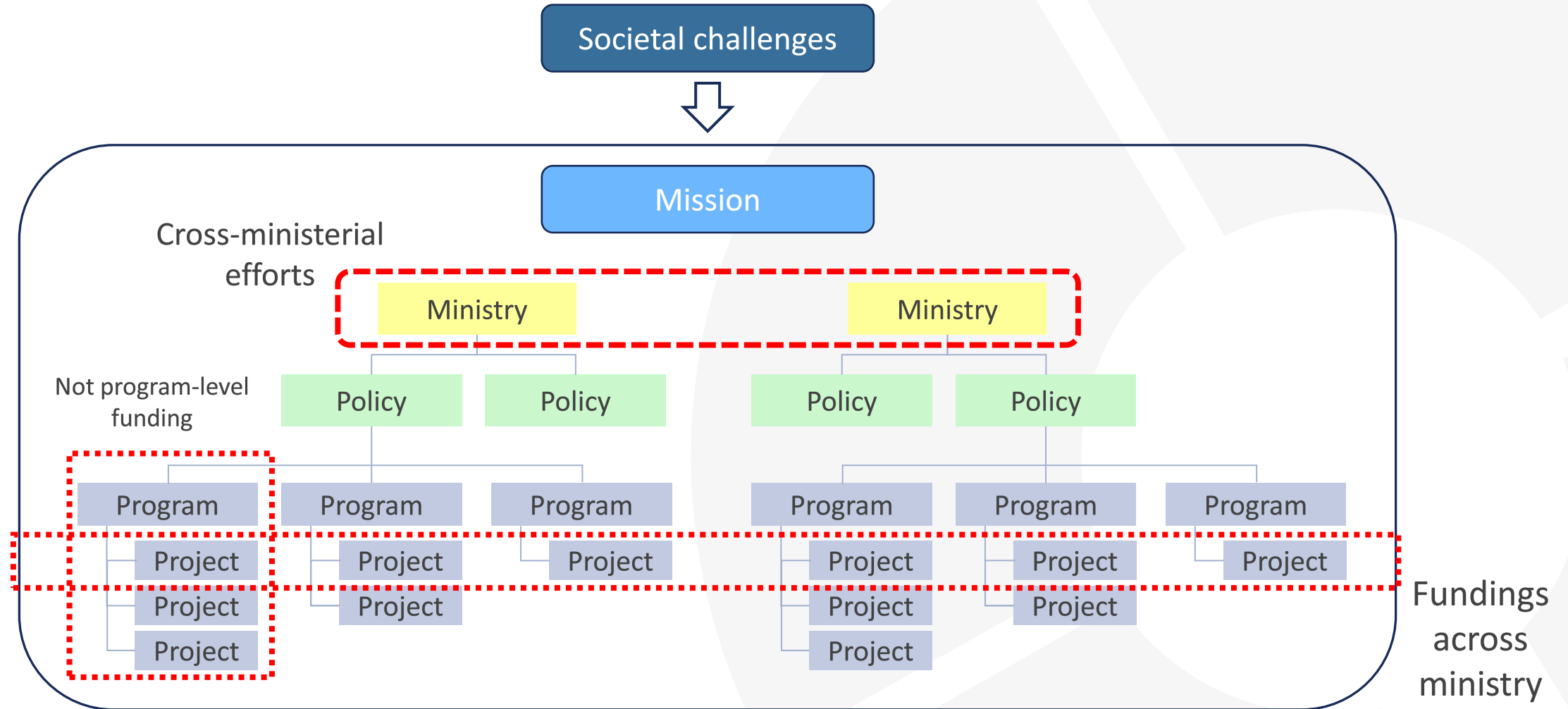
Research is required to contribute to climate change response

# Research questions

- Did policy affect funding and research?
  - In order to achieve the policy goal, government tries to steer the research direction
  - Funding is used as a policy instrument to induce research to contribute to its goals
    - Identify the extent of funding for green technology by technology area
- Did funding lead to desired research outcomes?
  - In principle, funded projects should produce the results described in the proposal
  - However, researchers may conduct research unrelated to the goals of the project
    - Investigate topics of publications from funded projects



# Need to look at project-level funding



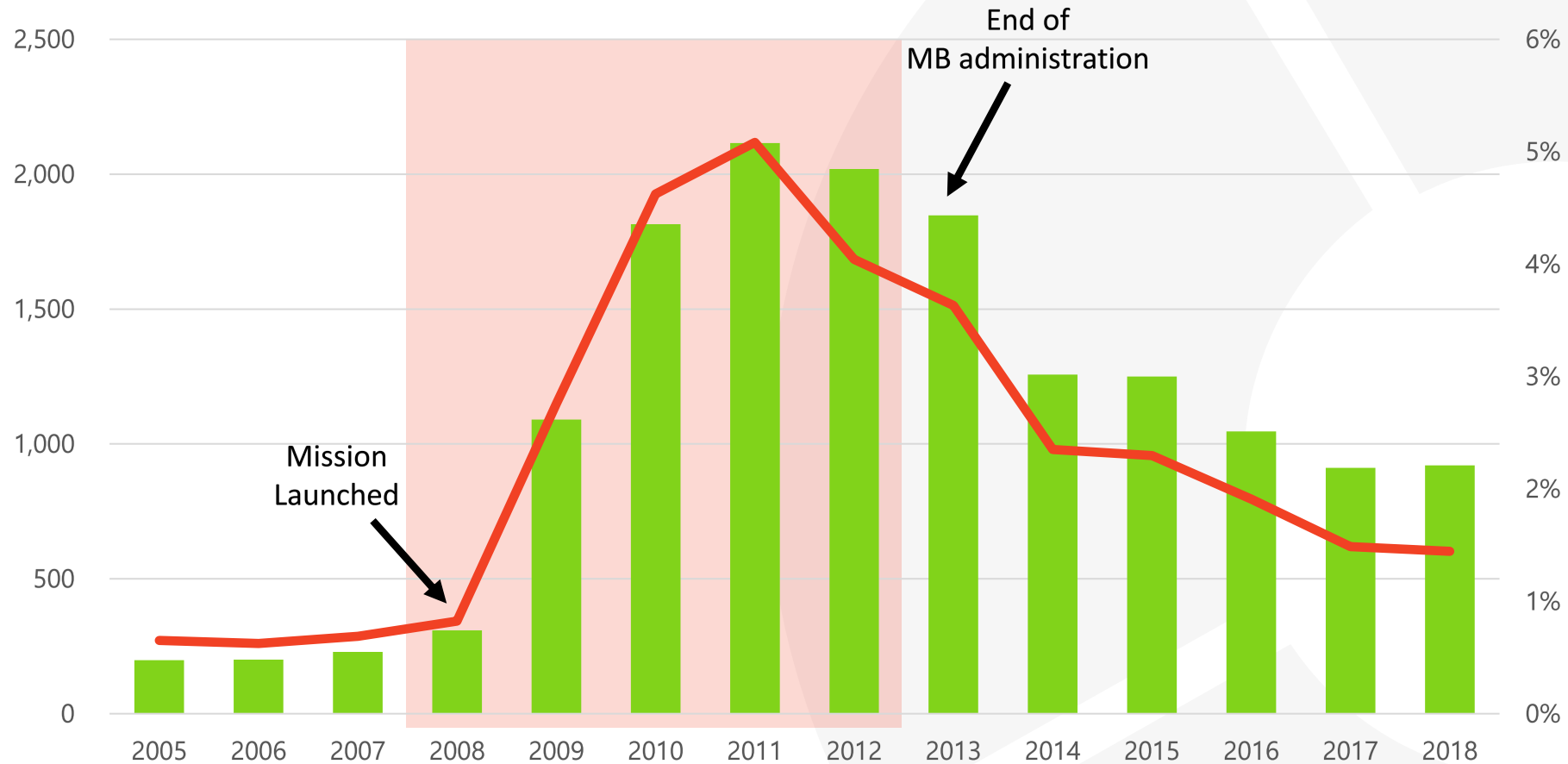
# Korean Green Growth

- National agenda of Lee Myung-bak administration (2008.2 -2013.2)
  - Climate change emerged as a global level challenge
  - Required economic stimulus after the Global Financial Crisis in 2008
- Create “new growth engines” through the Green mission
  - Invested in environmentally friendly industries
  - Development of green technology was crucial
  - Specified 27 key green technologies to be developed
- Launched Green R&D programs to achieve the policy goals



# Rise and fall of Green projects

## Projects mentioned “green” in the proposal



Bars (left): number of projects. Line (right): proportion of projects to total

## 27 Key Green Technologies

Category	Key Green Technologies
Climate change prediction and impact assessment	Climate change prediction
	Climate change impact adaptation
Renewable energy	Silicon-based solar cells
	Non-silicon solar cells
	Bio energy
Nuclear/Nuclear fusion	Light water reactors
	Fast reactors
	Nuclear fusion
Hydrogen and fuel cell	Hydrogen energy
	Fuel cell
Manufacturing	Plant growth-promoting
	Green Process technology
CTL and gasification	Integrated gasification combined cycle
Transportation	Green cars
	Intelligent infrastructure for transport and logistics

Category	Key Green Technologies
Green land	Green city
	Green buildings
Efficiency improvement in electricity	LED display and Green IT
	IT-combined electric machines
	Secondary batteries
Monitoring and Control of air pollution	CO <sub>2</sub> capture, storage, and processing
	Non-CO <sub>2</sub> processing
Water quality	Assessment of water quality and management
	Alternative water resources
Waste	Waste recycling
Waste and environment preservation	Monitoring of toxic pollutants and environmental remediation
Virtual reality	Virtual reality

# Methods





# Methods & Data

## ▪ Data

- NTIS (National Science & Technology Information Service)
  - Database of Korean government-funded projects and papers
  - Project: 1999-2018, Paper: 2007-2017 period (SCI papers only)
- Web of Science (CWTS in-house version)

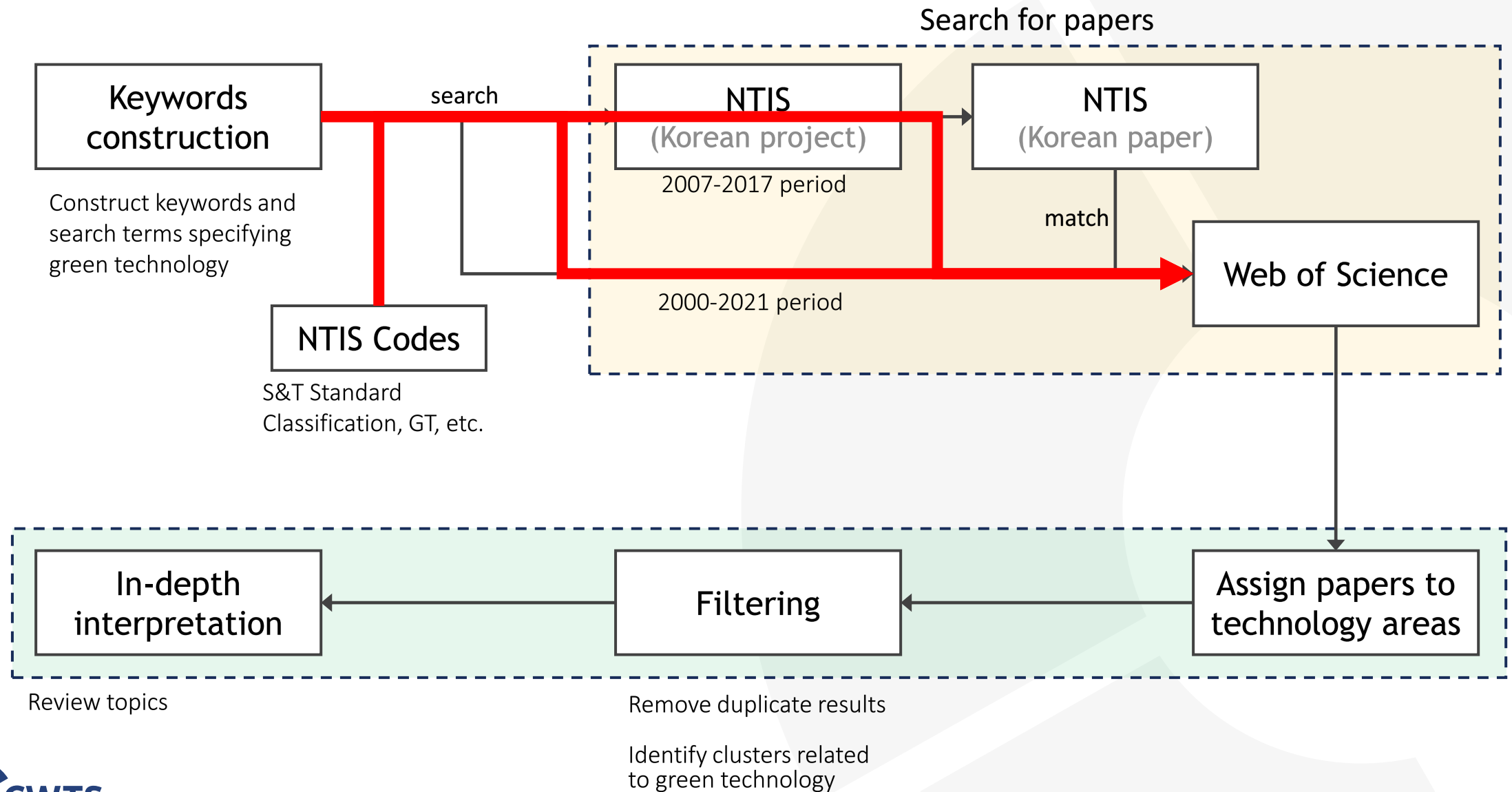
## ▪ Keyword construction (Korean & English)

- Technical terms to search for projects and papers
- Based on Korean government documents, technical literatures, and expert advice

## ▪ CWTS publication classification system

- Algorithmically generated article-level categorization – mapping distribution of research topics
- 4159 clusters with 5 labels to represent micro-level fields

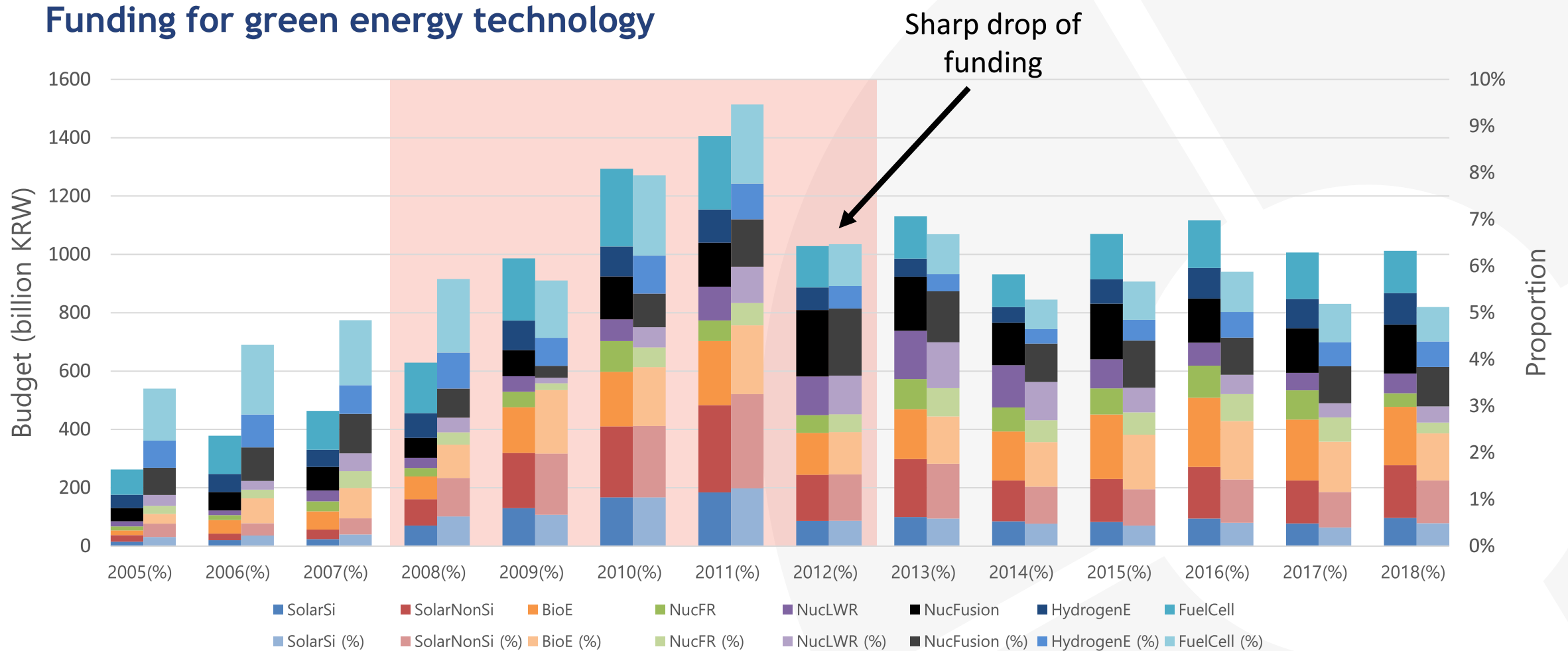
# Procedure



# Overall trends

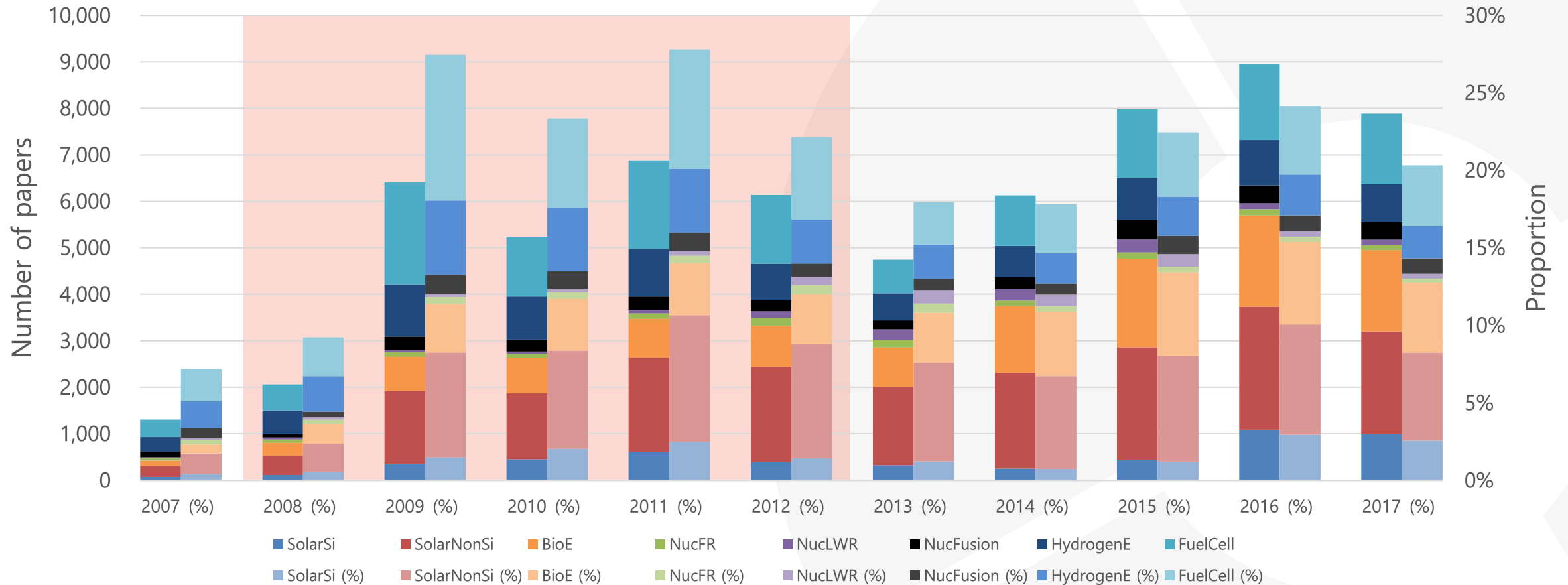


# Increase in funding for green technology



# Surge in research for green technology

## Papers published from projects of green energy technology





# Categorizing the relevance of papers



# Top 10 research areas of papers from bioenergy projects

## Research area and Subject category of the Web of Science

Research area	Count (frac)	Count (full)
Chemistry	2321.7	4093
Biotechnology & Applied Microbiology	1572.42	2670
Engineering	1349	2476
Materials Science	998.47	2310
Science & Technology - Other Topics	952.52	1938
Physics	690.25	1566
Energy & Fuels	662.88	1707
Biochemistry & Molecular Biology	586.78	1178
Plant Sciences	509.33	686
Microbiology	450.67	597

Subject category	Count (frac)	Count (full)
Biotechnology & Applied Microbiology	1567.57	2670
Chemistry, Multidisciplinary	1143.47	1999
Engineering, Chemical	757.78	1498
Materials Science, Multidisciplinary	692.3	1892
Energy & Fuels	660.93	1707
Chemistry, Physical	643.33	1471
Plant Sciences	506.08	686
Multidisciplinary Sciences	471	472
Biochemistry & Molecular Biology	465.93	961
Physics, Applied	464.75	1282

Makes sense,  
but are these all related to bioenergy?

# Approaches to characterize papers

## 1. Papers with keywords in title or abstract

Terms related to green technology are mentioned in the title or abstract

A simple way to identify relevance of papers

## 2. Manual investigation

Manual investigation of randomly selected papers

Judgment of relevance through a review of the abstracts

## 3. Publication classification system

Algorithmically generated article-level categorization

Characterize topics of clusters to determine relevance of papers

# 1. Papers with keywords in title or abstract

- Definition

- Terms used in search strings are mentioned in title or abstract
- Dataset for comparison: papers retrieved using terms from WoS

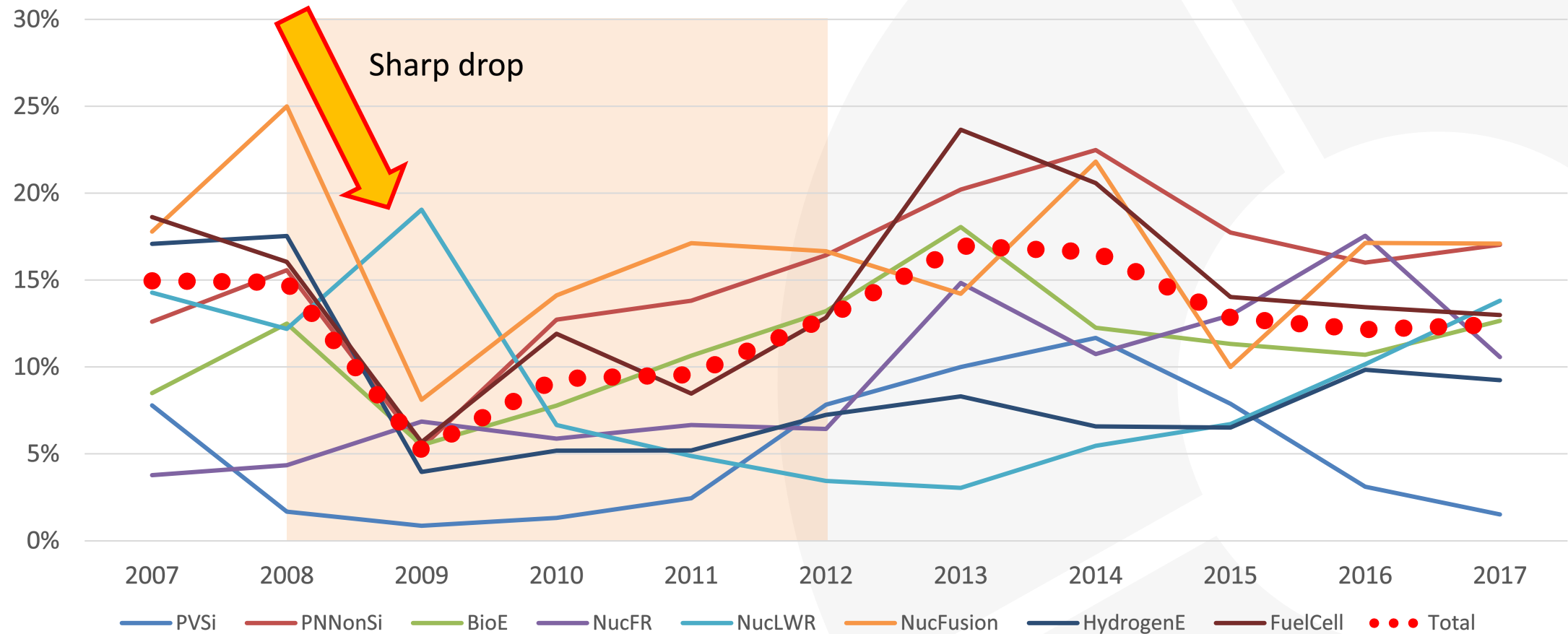
- Categorizing papers: direct or indirect

- Directly related to mission: Funded papers used green technology terms in title or abstract
- Indirectly related to mission
  - Extended dataset: cited publications by papers retrieved from WoS
  - Although green technology related terms were not mentioned, expected to be related to it

	PVSi	PVNonSi	BioE	NucFR	NucLWR	NucFusion	HydrogenE	FuelCell
Direct	9.0%	18.1%	12.2%	16.9%	9.7%	16.7%	7.6%	13.9%
Indirect	16.2%	20.9%	27.8%	19.9%	21.1%	14.0%	22.9%	19.8%
Unclear	74.8%	61.0%	59.9%	63.1%	69.2%	69.3%	69.5%	66.3%

# 1. Papers with keywords in title or abstract

After the mission was launched, proportion of papers directly related to mission decreased





## 2. Manual investigation

- Definition

- Manual investigation of randomly selected papers
- Sample size: confidence level 90% ± margin of error 10%

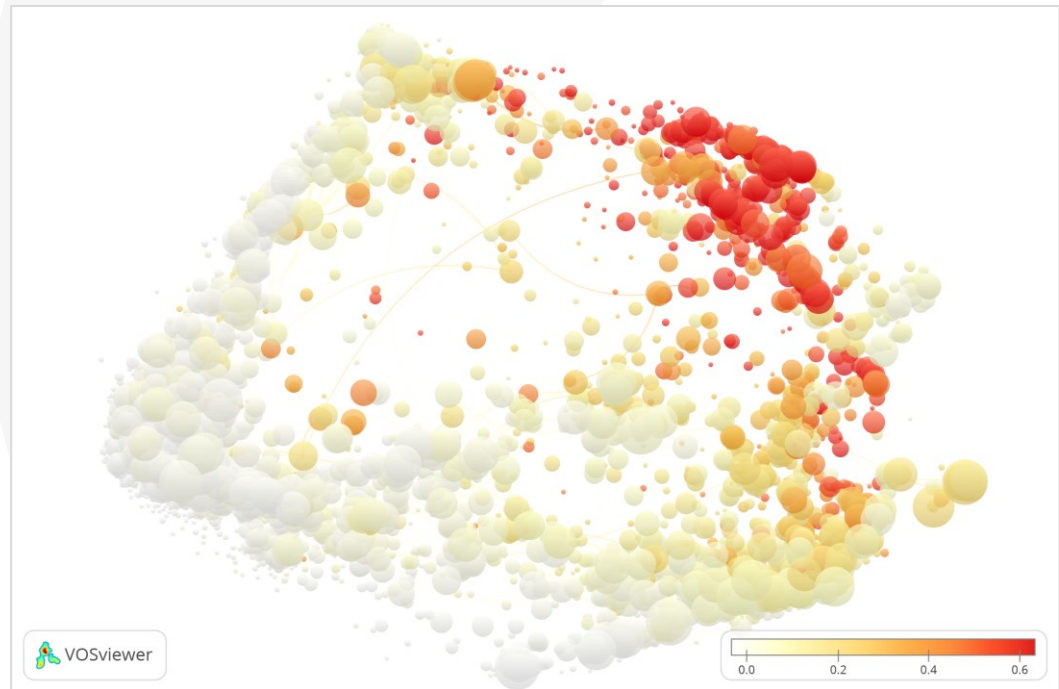
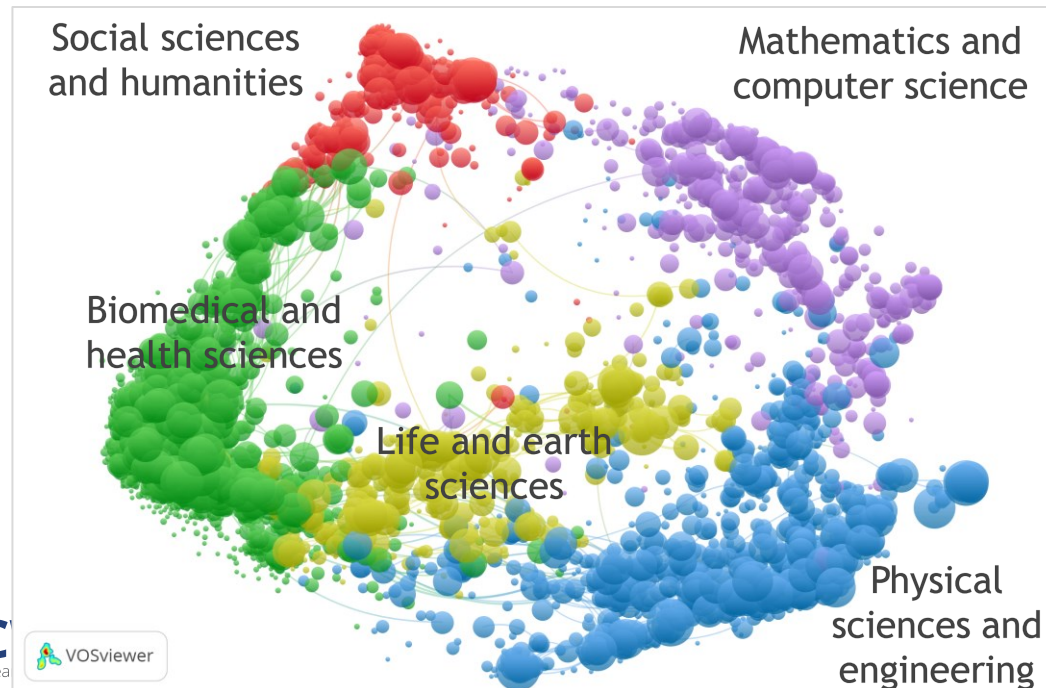
- Categorizing papers

- Direct: papers directly related to the development of green technology
- Indirect: not about green technology, but relevant topic

	PVSi	PVNonSi	BioE	NucFR	NucLWR	NucFusion	HydrogenE	FuelCell
<b>Sample</b>	68	68	68	65	65	67	68	68
<b>Population</b>	5,099	18,736	11,485	1,259	1,396	2,888	8,606	14,257
<b>Direct</b>	14.7%	23.5%	16.2%	26.2%	20.0%	26.9%	17.6%	22.1%
<b>Indirect</b>	26.5%	33.8%	39.7%	35.4%	33.8%	35.8%	36.8%	29.4%
<b>Unclear</b>	58.8%	42.6%	44.1%	38.5%	46.2%	37.3%	45.6%	48.5%

### 3. Publication classification system

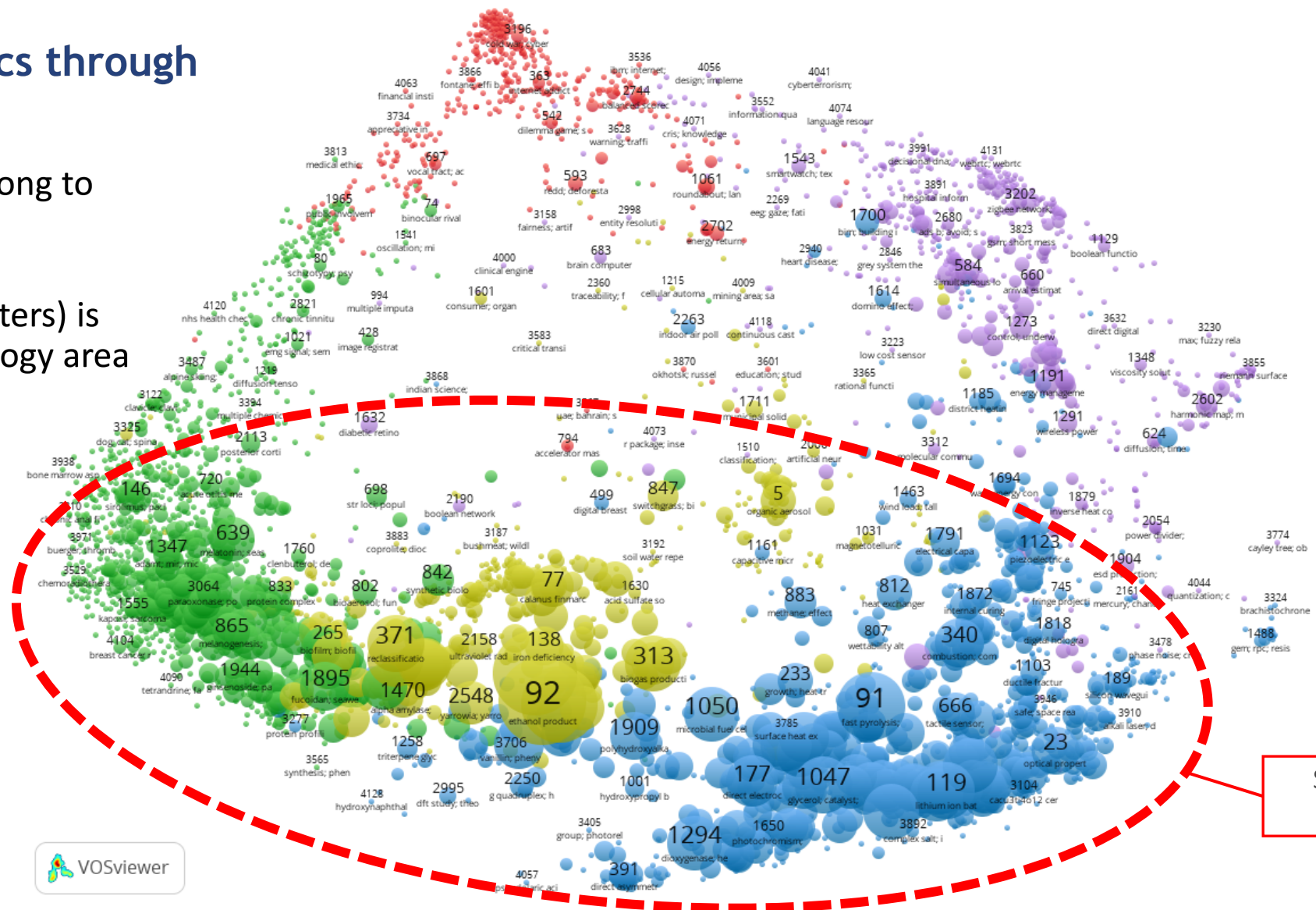
- Algorithmically defined fields
  - Clustering papers based on citation relations between publications
  - Each publication in the Web of Science was assigned to one of the 4159 fields
- Interpret topics of papers through labels of each micro-level cluster



## Overlay map – bioenergy

## Interpret research topics through the labels of clusters

- Some technical terms belong to specific domains
- Distribution of terms(clusters) is different for each technology area



# Categorizing clusters

- Which clusters are related to green technology?
  - Algorithmically constructed clusters represent research topics
  - Each paper is assigned to only one cluster
- Criteria (strict) – direct relevance
  - Criteria for clusters related to green technology
  - Manual investigation of clusters above thresholds (based on proportion and number of papers in cluster)
  - Based on all papers retrieved from WoS using green technology keywords
- Criteria (loose) – direct and/or indirect relevance
  - Picking clusters directly or indirectly related to green technology (above thresholds)

	PVSi	PVNonSi	BioE	NucFR	NucLWR	NucFusion	HydrogenE	FuelCell
Direct	8.4%	22.0%	15.3%	38.1%	26.8%	32.6%	16.8%	20.6%
Indirect	25.9%	18.0%	15.1%	6.5%	16.4%	10.7%	10.8%	6.5%
Unclear	65.7%	60.0%	69.6%	55.4%	56.8%	56.7%	72.4%	72.9%



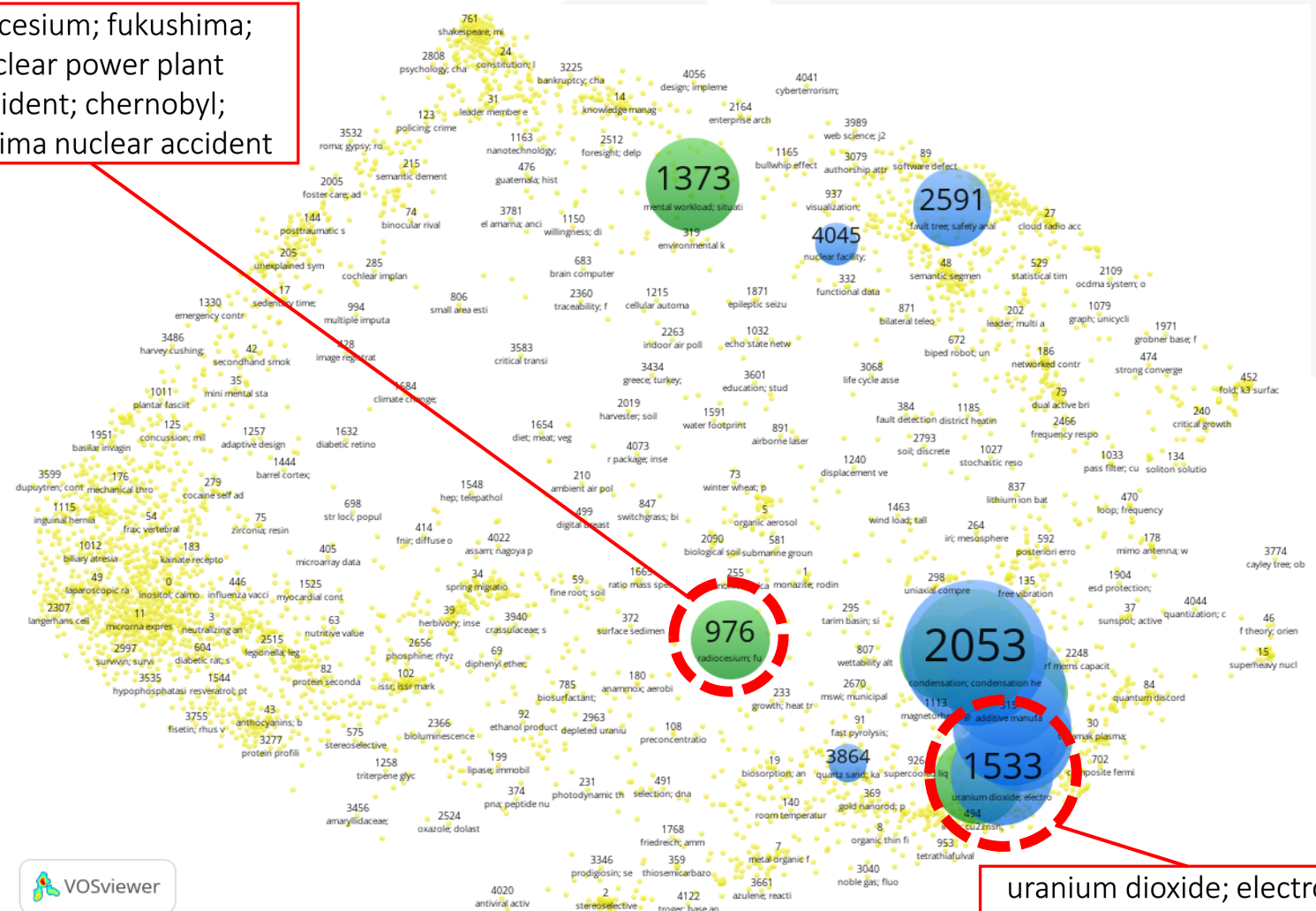
# Direct & indirect outcomes – Light water reactors

radiocesium; fukushima;  
nuclear power plant  
accident; chernobyl;  
fukushima nuclear accident

## How to understand these clusters?

- Some topics were in line with the government's intentions, some did not
- What do these clusters mean for nuclear power research?

Cluster 976 is not about development of nuclear power technology (direct), but is related to nuclear power (indirect)



uranium dioxide; electronic  
structure; uo2;  
thermodynamic property;  
tho2



# Summary

- Proportion of papers related to the mission was low
  - Many funded papers were identified with unclear relevance
- Not all funded papers were about green energy technology

	PVSi	PVNonSi	BioE	NucFR	NucLWR	NucFusion	HydrogenE	FuelCell
<b>1. Terms in title or abstract</b>								
<b>Direct</b>	9.0%	18.1%	12.2%	16.9%	9.7%	16.7%	7.6%	13.9%
<b>Indirect</b>	16.2%	20.9%	27.8%	19.9%	21.1%	14.0%	22.9%	19.8%
<b>Unclear</b>	74.8%	61.0%	59.9%	63.1%	69.2%	69.3%	69.5%	66.3%
<b>2. Random sample test</b>								
<b>Direct</b>	14.7%	23.5%	16.2%	26.2%	20.0%	26.9%	17.6%	22.1%
<b>Indirect</b>	26.5%	33.8%	39.7%	35.4%	33.8%	35.8%	36.8%	29.4%
<b>Unclear</b>	58.8%	42.6%	44.1%	38.5%	46.2%	37.3%	45.6%	48.5%
<b>3. Publication classification system</b>								
<b>Direct</b>	8.4%	22.0%	15.3%	38.1%	26.8%	32.6%	16.8%	20.6%
<b>Indirect</b>	25.9%	18.0%	15.1%	6.5%	16.4%	10.7%	10.8%	6.5%
<b>Unclear</b>	65.7%	60.0%	69.6%	55.4%	56.8%	56.7%	72.4%	72.9%

# Conclusion



# Implications & answers to research questions

## ■ Research questions and answers

- Q. Did policy affect funding and research? A. Quantitative increase was clearly present
- Q. Did funding lead to desired research outcomes? A. Not everything was successful

## ■ Clear directionality did not necessarily lead to the desired outcome

- Korean Green Initiative was technology-oriented, and targeted technological areas to be developed
- However, the proportion of papers directly or indirectly related to the mission was low

## ■ Why did this happen? (issues to be analyzed, hypotheses)

- Limitations of monitoring: funders cannot assess the outcome of all projects
- Strategy of researchers : buzz words for resources, researches unrelated to proposals

Thank you

