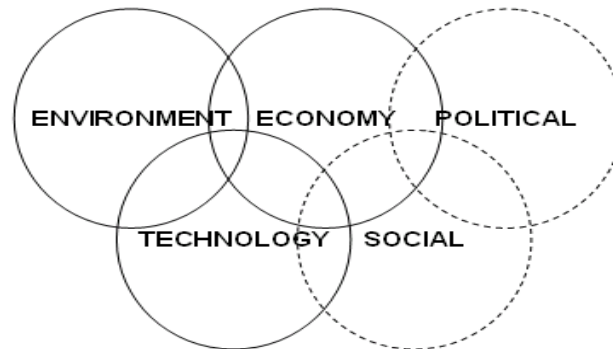


Fortum and Neste Foundation

Focus Areas of Research

**Based on EU level objectives for security of supply,
competitiveness and sustainability**



Focus domains

1 Power and heat production

- 1.1 Coal
- 1.2 Gas
- 1.3 Oil
- 1.4 Peat
- 1.5 Biomass
- 1.6 Waste
- 1.7 Nuclear fission
- 1.8 Nuclear fusion
- 1.9 Nuclear waste
- 1.10 Hydro
- 1.11 Wind
- 1.12 Solar
- 1.13 Wave
- 1.14 Fuel cells
- 1.15 Geothermal energy

2 Electricity distribution

- 2.1 Automation
- 2.2 Network/Lines
- 2.3 Substations/Equipments
- 2.4 Smart grids

3 Heat and cooling distribution

- 3.1 New technologies
- 3.2 Network/Pipes
- 3.3 Substations/Equipments
- 3.4 Efficient use
- 3.5 Prosumers

4 Efficient use of electricity

- 4.1 Industry
- 4.2 Services
- 4.3 End customers

5 Efficient use of heat/cooling

- 5.1 Industry
- 5.2 Services
- 5.3 End-customers

6 New business models based on decentralization and storages

- 6.1 Energy storages
- 6.2 Demand side management / Demand response
- 6.3 Virtual power plants/Load aggregation
- 6.4 Electric transportation
- 6.5 Smart city and regional energy Concepts

7 Market mechanisms

- 7.1 Nordic/EU
- 7.2 EU/Russia
- 7.3 Global
- 7.4 Market models

8 Socio-economic, behavioral issues

- 8.1 Society
- 8.2 Business
- 8.3 End customer

9 Oil refining and transportation fuels

- 9.1 Raw materials for fossil fuels
- 9.2 Raw materials for renewable fuels
- 9.3 Processes for fossil fuels
- 9.4 Processes for renewable fuels
- 9.5 Fossil fuel products
- 9.6 Renewable fuel products
- 9.7 Efficient use of energy in transportation

10 Bioeconomy, Circular-economy and Chemistry

- 10.1 Chemical energy technologies
- 10.2 Integration between industrial clusters
- 10.3 Biorefining technologies
- 10.4 Speciality products
- 10.5 Solutions for circular-economy

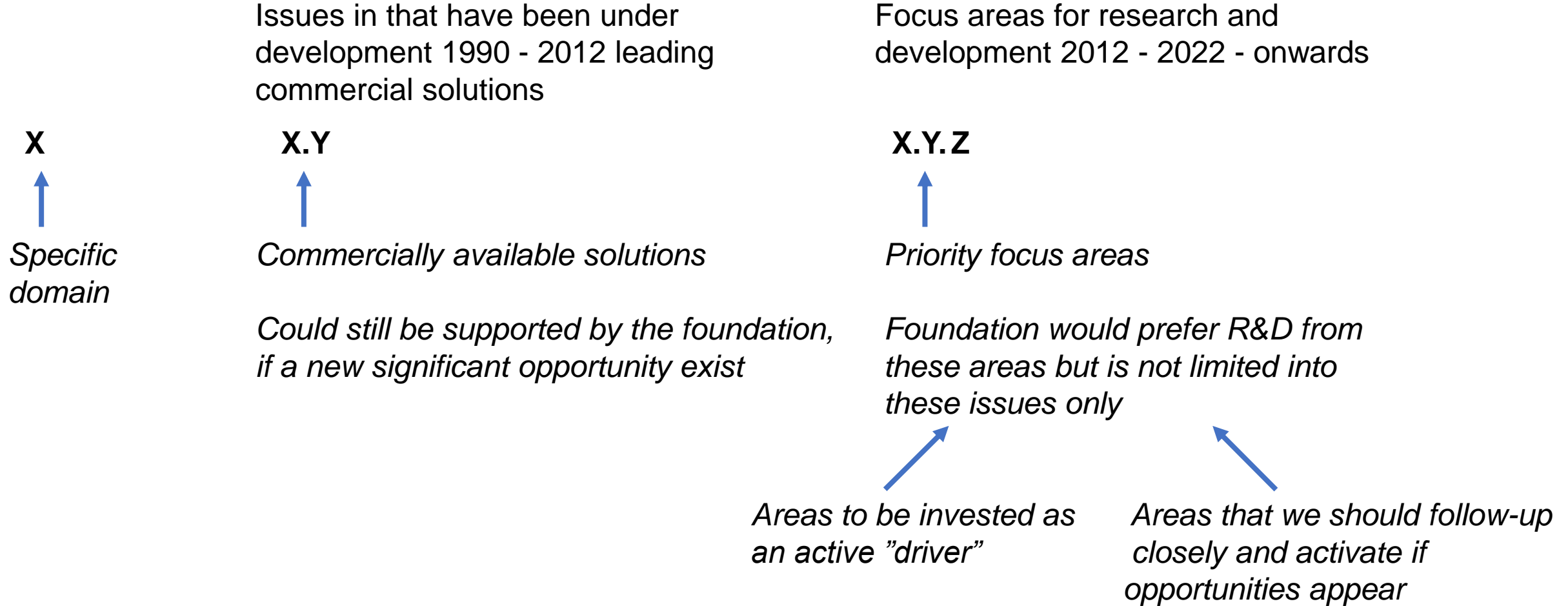
11 Novel materials for energy technologies

- 11.1 Catalysis and catalysts
- 11.2 Materials for solar energy
- 11.3 Materials for energy storage
- 11.4 Superconductivity

12 New digital solutions for energy

20 Other

Domains and focus areas



Note! Also, basic research (like in materials science) could be supported from the foundation. However, in such case the focus areas that will get benefits must be identified.

1. Power and heat production

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Coal
1.1 NO_x, SO_x, particle and mercury cleaning
By-product utilization (gypsum, fly ash)
Characterization of coal (combustion properties)

1.1.1 Coal/Bio/waste coburning
1.1.2 CCS new / retrofits; oxyfiring
1.1.3 IGCC
1.1.4 New emissions req./ IED 2020, heavy metals
1.1.5 Remote and mobile tools (O&M etc.)
1.1.6 Materials for higher steam values

Gas
1.2 Efficiency development CCGT
Stationary engine-based CHP
Expansion of gas in traffic
Anaerobic digestion with methane upgrading

1.2.1 CCS
1.2.2 SNG/LNG replacing NG
1.2.3 Biogas replacing NG
1.2.4 Shale/tight gas recovery
1.2.5 Fuel cells with reformers

Oil
1.3 Low sulfur fuels traffic and heating oils
First generation bio-oils
Converting to wood pellets

1.3.1 Second generation bio-oils
1.3.2 Integration of energy production with bio refineries

1. Power and heat production

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Peat
1.4 Production technology
Combustion with diff. fuels mixed with peat
CO2 emissions from peat cutting

Biomass
1.5 Co-combustion of biomass & peat
New grades of biomass (e.g. agro-based)
Retrofit gasification concepts
Pellets
Harvesting, logistics etc.

Waste
1.6 Source separation of waste fractions
High power/heat ratio solutions
Increase in plant unit sizes
Flue gas emission control

Focus areas for research and
development 2012 - 2022 - onwards

1.4.1 CCS (if peat will be accepted)
1.4.2 Sustainability of peat chain
1.4.3 Better moisture management

1.5.1 Multi-fuel boilers, bio only options
1.5.2 Increased electricity production, new materials, corrosion
1.5.3 Integrated bio-refineries & erosion
1.5.4. Torrefaction
1.5.5 Sustainable bio chain
1.5.6 Utilization of ashes
1.5.7 New fuel concepts
1.5.8 International trade of biomass

1.6.1 Gasification + gas cleaning
1.6.2 Digestion & energy efficiency, land fill gas
1.6.3 High power/heat ratio further development
1.6.4 Annual efficiency impr. (summertime heat)
1.6.5 Corrosion/erosion/coatings related issues
1.6.6 Trends in the waste composition
1.6.7 Utilization of bottom ash

1. Power and heat production

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Nuclear
Fission
1.7
Development of Generation 3+ reactors
Improvement of nuclear fuel efficiency
Improvement of the plant availability
Plant life management and upgrading
Advanced licensing analysis and
simulator tools

Nuclear
Fusion
1.8
Development of ITER reactor
and related technologies
Scientific breakeven with large
magnetic devices

Nuclear
waste
1.9
Deep geological repository of spent fuel

1.7.1 Generation 4 systems
1.7.2 Safer, modular concepts
1.7.3 Nuclear cogeneration: CHP and desalination
1.7.4 Nuclear process heat and hydrogen generation
1.7.5 Fast breeder reactors (U-238)
1.7.6 Thorium fuel cycle
1.7.7 3D-models for fluid dynamics

1.8.1 Tritium breeding technologies
1.8.2 Fusion reactor material development
1.8.3 Development of DEMO fusion power plant
1.8.4 Inertial confinement

1.9.1 Closed fuel cycle issues: breeder technology,
reprocessing, transmutation

1. Power and heat production

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Hydro
1.10 Sustainability improvements
Improved flow control

- 1.10.1 New ways utilizing hydro
- 1.10.2 Concrete lifetime extension
- 1.10.3 Dam Safety
- 1.10.4 River system optimization

Wind
1.11 Control of power output
Gear problems
Mechanical noise

- 1.11.1 Icy conditions / Offshore applications
- 1.11.2 High towers, stronger basic construction
- 1.11.3 Life-time ext./ mechanical durability
- 1.11.4 New light materials
- 1.11.5 Power outage increase
- 1.11.6 Reduce bird collisions / (Aerodyn. noise)
- 1.11.7 In-land wind technology

1. Power and heat production

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Solar
1.12
Photovoltaics:
- Crystalline silicon I techn's, reduc. silicon use
- Cell efficiency degravation
- Balance of system
- Sun tracking
Concentrating Solar Power (CSP)

1.12.1 Nanomaterials in thin film cells
1.12.2 Organic cells
1.12.3 Thermal PVs, quantum wells
1.12.4 High efficiency multi-junction cells
1.12.5 Use of surface plasmons
1.12,6 Utility scale CSP

Wave
1.13
Sea cables and installation techniques

1.13.1 Test parks
1.13.2 Under surface installations
1.13.3 Protection for extreme conditions

Fuel
cells
1.14
Commercially available, micro scale (<1kW)
solution

1.14.1 Solid Oxide Fuel Cells
1.14.2 Proton Exchange Membrane cells
1.14.3 Molten carbonate fuel cells
1.14.4 Other new medium and large-scale cells

Geothermal
energy
1.15

1.15.1 Novel solutions of geothermal energy

2. Electricity distribution

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Automation
2.1 Smart grid and end-user products

Network/
Lines
2.2 Traditional way of constructing networks
Wires -> cables

Substations
Equipments
2.3 Condition monitoring for condition based
maintenance

Focus areas for research and
development 2012 - 2022 - onwards

2.1.1 Develop grid as an enabler of new end-user solutions
(visualisation of consumption and distributed production)
2.1.2 Standardized grid codes
2.1.3 Self-healing networks
2.1.4 High availability IT support (storms, etc.)

2.2.1 Microgrids => Two-way energy flow for distributed
energy productions
2.2.2 High temperature superconductors

2.3.1 Improved control of substations and other grid nodes
through better data
2.3.2 Cost reduction of standard components

3. Heat and cooling distribution

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Automation
3.1 AMR – hourly measurement

- 3.1.1 Peak load management
- 3.1.2 Individual measuring
- 3.1.3 Separate water and heat measuring

Network/pipes
3.2 Improved design and materials to
extend life time
District cooling

- 3.2.1 Cost reduction – new materials, new simple constructions
- 3.2.2 More simple methods for deposition
- 3.2.3 Life time prediction concepts

Substations
Equipments
3.3 Standardized components
Hourly meters
Geothermal solutions

- 3.3.1 Modular/pre-fabricated sub-stations
- 3.3.2 Adaption the sub stations to passive houses, low energy house etc.
- 3.3.3 Advanced geothermal

4. Efficient use of electricity

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Industry 4.1	Adjustable speed drives Permanent magnet technology Various process improvements
Services 4.2	Various improvements First Green IT applications
End customers 4.3	Reduced power consumption in devices and buildings Demand response solutions for peak shaving (in summer)

- 4.1.1 Various energy efficiency improvements using for example separation techniques
- 4.1.2 Basic processes taking energy efficiency into account
- 4.2.1 Energy efficiency products developed for end customer use
- 4.2.2 Electric transportation
- 4.2.3 Green IT
- 4.3.1 ICT and automation as tools for increasing efficiency of uninterrupted electricity use
- 4.3.2 Standardization of customer gateways and related ICT structures
- 4.3.3 Customer as a producer
- 4.3.4 Electric transportation

5. Efficient use of heat and cooling

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Industry 5.1	Energy efficiency analyses and improvements Utilization of industrial waste heat	5.1.1 Integration of power/heat production with customer's processes 5.1.2 Utilization of industrial waste heat
Services 5.2	Energy efficiency services Heat pumps (geothermal, air)	5.2.1 Competitive cooling concepts integrated with district heating 5.2.2 Utilization of waste heat
End customers 5.3	Energy efficiency services Heat pumps (geothermal, air)	5.3.1 Competitive cooling concepts integrated with district heating 5.3.2 Increased use of heat -dishwashers, washing machines etc.

6. New business models based on decentralization and storages

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Energy storages 6.1	Pumping hydro power plants Traditional heat storages in district heating Commercial small-scale batteries	6.1.1 Utility scale seasonal storages (electricity/heat) 6.1.2 New battery technologies for electricity 6.1.3 Chemical (methane, etc.) and material technology-based storages.
Demand side mgmt Demand response 6.2	Traditional peak shaving technologies	6.2.1 Various ways to use distributed energy system
Virtual power plants / Load aggregation 6.3	Fleet management of large and mediumsize plants	6.3.1 Fleet management and optimisation of a multitude of very small production units
Electric transportation 6.4		6.4.1 Electric transportation infrastructure 6.4.2 Electric vehicles 6.4.3 Automatic control
Smart city / Regional energy concepts 6.5		6.5.1 Energy system integration 6.5.2 Multi-carrier energy networks 6.5.3 Energy systems architecture

7. Market mechanisms in energy sector

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Nordic
EU
7.1

Unbundling distribution and sales
Pan-Nordic electricity exchange

- 7.1.1 Intermittent generation
- 7.1.2 Creative solutions for remaining bottlenecks
- 7.1.3 Exchange integration
- 7.1.4 Weather forecasting improvements
- 7.1.5 Extreme conditions forecasts

EU-Russia
7.2

- 7.2.1 Energy efficiency (esp. Russia)
- 7.2.2 EU-Russia market analyses and integration

Global
7.3

- 7.3.1 Micro markets / mass production of gen units /solar economy
- 7.3.2 Hydrogen/methane economy
- 7.3.3 New material like nano,...
- 7.3.4 International biofuel markets
- 7.3.5 Energy and other regulations impacts into the sector

Market models
7.4

- 7.4.1 New market models / market: design-capacity vs. energy only, balancing power solutions, etc.

8. Socio-economic, behavioral issues

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Society
8.1

Awareness of environmental problems

- 8.1.1 Models for distributed generation; design, supply, use
- 8.1.2 Sustainable cities
- 8.1.3 CCS acceptance of storage
- 8.1.4 Critical / harmful materials
- 8.1.5 Attitudes for energy
- 8.1.6 Global boundaries and energy sector

Business
8.2

Various pricing models
CO2 trade

- 8.2.1 Use of real time electricity consumption in services
(comfort, security, entertainment, ...)
- 8.2.2 Diffusion of innovations in energy business
- 8.2.3 The effects of CSR on the energy business

End-
customers
8.3

Regulatory steps towards improved and
timely measured use of electricity

- 8.3.1 Customers active participation on energy markets and
services supporting this
- 8.3.2 Increased customer awareness and engagement in efficient
use of electricity-transfer of elastic loads to lower prices
- 8.3.3 Constructive attitude towards changes

9. Oil refining and transportation fuels

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Raw materials
for fossil fuels
9.1

Unconventional fossil feedstock development:
condensates, off-shore deep water, heavy
bottom oil

9.1.1 More demanding feedstock development: gas hydrates,
oil shales etc.

Raw materials
for renewable
fuels
9.2

Feedstock for first generation biofuels:
feedstock from conventional food chain:
sugar, grains, soy oil, rapeseed oil, palm oil

9.2.1 More sustainable feedstock: out of food chain, better
yields, use of degraded land, totally new solutions like
microbes and algae

Processes for
fossil fuels
9.3

Heavy oil upgrading technology

9.3.1 Zero bottom oil technologies, hydrotreatment, energy
efficiency

Processes for
renewable fuels
9.4

Hydrogenated vegetable oil technology, with
high product quality

9.4.1 Processes for utilization and pre-treatment of new
renewable feedstock: lignocellulosic biomass, algae &
microbe oils, gasification and upgrading.

9. Oil refining and transportation fuels

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Fossil fuel
products
9.5

Regulated emissions reduced.

9.5.1 More strict sustainability criteria

Renewable
fuel products
9.6

Hydrogenated vegetable oil for diesel with
high product quality

9.6.1 More strict sustainability criteria

9.6.2 Fully fungible biofuels.

Efficient use
of energy in
transportation
9.7

9.7.1 New solutions for efficient use of energy in transportation

10. Bioeconomy, Circular-economy and Chemistry

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Chemical
Energy
Technologies
10.1

Combustion technologies.
Conventional catalysis and catalytic
processes.
Separation technologies of hydrocarbons

Integration
between
industrial
clusters
10.2

Biorefining
technologies
10.3

Focus areas for research and
development 2012 - 2022 - onwards

- 10.1.1 Novel technologies incl. unit processes and catalysis for oil refining
- 10.1.2 Valorization of biomass to liquid traffic fuels and its components
- 10.1.3 Biogas conversion technologies
- 10.1.4 Innovative unit operations and processes including catalysis
- 10.2.1 Complementary refining and value chains from renewable raw materials to production of high value-added products
- 10.2.2 Energy efficiency of integration
- 10.3.1 Biomass degradation and fractionation
- 10.3.2 Chemical and biotechnical methods for valorization
- 10.3.3 Bioenergy, bio-based chemicals and biomaterials
- 10.3.4 Total utilization of biomass

10. Bioeconomy, Circular-economy and Chemistry

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Speciality
Products
10.4

10.4.1 High value-added bio-based products with functional
properties

Solutions for
circular-
economy
10.5

10.5.1 Novel technologies and concepts
10.5.2 Innovative unit operation and processes

11. Novel materials for energy technologies

Issues in that have been under development
1990 - 2012 leading to commercial solutions

Focus areas for research and
development 2012 - 2022 - onwards

Catalysts
and catalysis
11.1

Catalysts for petrochemicals and hydrogen
conversion.

11.1.1 Catalysts and processes for increased feedstock
flexibility, higher yields, and better energy efficiency.

11.1.2 Catalysts and processes for renewable feedstocks

11.1.3 Bioenergy technologies

11.1.4 Water splitting

Materials for
solar energy
11.2

Si-based solar cell technologies
and solutions based on them

11.2.1 Novel photovoltaic molecules and materials

Materials for
energy
storage
11.3

Li-Ion battery technology
Solid oxide fuel cells
Polymer electrolyte membrane fuel cells

11.3.1 Nanomaterials

11.3.2 Supercapacitors

11.3.3 High energy density, light cold sustaining materials.

11.3.4 Chemical energy storage technologies

11.3.5 Hydrogen energy technologies, production and storage

11.3.6 Thermoelectric materials

Superconduc
tivity
11.4

11.4.1 Novel applications of superconductivity

12. New digital solutions for energy

Applications to this area are highly welcomed and will be classified separately by the Foundation

20. Other

Will be classified separately by the Foundation