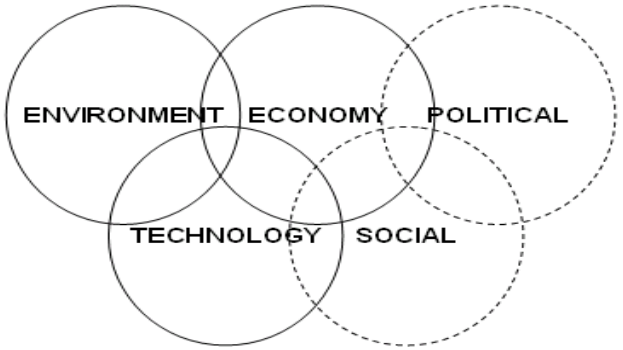
Fortum and Neste Foundation

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

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

Focus areas for research and development 2012 - 2022 - onwards

X

Specific domain

X.Y

Commercially available solutions

Could still be supported by the foundation, if a new significant opportunity exist

X.Y. Z

Priority focus areas

Foundation would prefer R&D from these areas but is not limited into these issues only

Areas to be invested as an active ”driver”

Areas that we should follow-up closely and activate if opportunities appear

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	NOx, SOx, 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	Focus areas for research and development 2012 - 2022 - onwards
Peat 1.4	Production technology Combustion with diff. fuels mixed with peat CO2 emissions from peat cutting	1.4.1 CCS (if peat will be accepted) 1.4.2 Sustainability of peat chain 1.4.3 Better moisture management
Biomass 1.5	Co-combustion of biomass & peat New grades of biomass (e.g. agro-based) Retrofit gasification concepts Pellets Harvesting, logistics etc.	1.5.1 Multi-fuel boilers, bio only options 1.5.2 Increased electricity production, new materials, corrosion & erosion 1.5.3 Integrated bio-refineries 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
Waste 1.6	Source separation of waste fractions High power/heat ratio solutions Increase in plant unit sizes Flue gas emission control	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	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
Nuclear Fusion 1.8	Development of ITER reactor and related technologies Scientific breakeven with large magnetic devices	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
Nuclear waste 1.9	Deep geological repository of spent fuel	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	Sustainablity 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 noice	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 l techn's, reduc. silicon use - Cell efficiency degratation - 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	Focus areas for research and development 2012 - 2022 - onwards
Automation 2.1	Smart grid and end-user products	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.)
Network/ Lines 2.2	Traditional way of constructing networks Wires -> cables	2.2.1 Microgrids => Two-way energy flow for distributed energy productions 2.2.2 High temperatrure supraconductors
Substations Equipments 2.3	Condition montoring for condition based maintenance	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
Netwok/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 depostion 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	4.1.1 Various energy efficiency improvements using for example separation techniques 4.1.2 Basic processes taking energy efficiency into account
Services 4.2	Various improvements First Green IT applications	4.2.1 Energy efficiency products developed for end customer use 4.2.2 Electric transportation 4.2.3 Green IT
End customers 4.3	Reduced power consumption in devices and buildings Demand response solutions for peak shaving (in summer)	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 produtcs 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	Focus areas for research and development 2012 - 2022 - onwards
Chemical Energy Technologies 10.1	Combustion technologies. Conventional catalysis and catalytic processes. Separation technologies of hydrocarbons	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
Integration between industrial clusters 10.2		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
Biorefining technologies 10.3		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
Superconductivity 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