

Fortum Foundation focus areas

- 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

Generic domains (1-10)

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

Focus areas for research and development 2012-2020

XXX

YYY

ZZZ



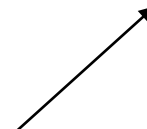
Specific domain

Commercially available solutions

Priority focus areas

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

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 commercial solutions

Focus areas for research and development 2012-2020

Coal
1.1

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

Coal/Bio/waste coburning
CCS new / retrofits; oxyfiring
IGCC
New emis req./ IED 2020, heavy metals
Remote and mobile tools (O&M etc.)
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

CCS
SNG/LNG replacing NG
Biogas replacing NG
Shale/tight gas recovery
Fuel cells with reformers

Oil
1.3

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

Second generation bio oils
Integration of energy production
with bio refineries

1. Power and heat production

Issues in that have been under development 1990-2012 leading commercial solutions Focus areas for research and development 2012-2020

Peat 1.4	Production technology Combustion with diff. fuels mixed with peat CO2 emissions from peat cutting	CCS (if peat will be accepted) Sustainability of peat chain 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	Multi-fuel boilers, bio only options Increased electricity production, new materials, corrosion, erosion Integrated bio-refineries Torrefaction Sustainable bio chain Utilization of ashes New fuel concepts 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	Gasification + gas cleaning Digestion & energy efficiency, land fill gas High power/heat ratio further devel. (1) Annual efficiency impr. (summertime heat) Corrosion/erosion/coatings related issues Trends in the waste composition Utilization of bottom ash

1. Power and heat production

Issues in that have been under development 1990-2012 leading commercial solutions Focus areas for reaserch and development 2012-2040

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	Generation 4 systems Safer modular concepts including phenomenological basis Nuclear process heat and hydrogen gener. Fast breeder reactors (U-238) Thorium fuel cycle 3D-models for fluid dynamics including experimental basis Utilization on nuclear heat (district heating, desalination, industrial process heat, hydrogen production)
Fusion 1.8	Development of ITER reactor and related technologies Scientific breakeven with large magnetic devices	Tritium breeding technologies Fusion reactor material development Development of DEMO fusion power plant Inertial confinement
Nuclear waste 1.9	Deep geological repository of spent fuel	Closed fuel cycle issues: breeder technology, reprocessing, transmutation

1. Power and heat production

Issues in that have been under development 1990-2012 leading commercial solutions Focus areas for research and development 2012-2020

Hydro 1.10	Sustainability improvements Improved flow control	New ways utilizing hydro Concrete life time extension Dam Safety River system optimisation
Wind 1.11	Control of power output Gear problems Mechanical noise	Icy conditions / Offshore applications High towers, stronger basic construction Life-time ext./ mechanical durability New light materials Power outage increase Reduce bird collisions / (Aerodyn. noise) In-land wind technology

1. Power and heat production

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

Focus areas for research and development 2012-2020

Solar
1.12

Photovoltaics:
- Crystalline silicon I techn's, reduc. silicon use
- Cell efficiency degratation
- Balance of system
- Sun tracking

Concentrating Solar Power (CSP)

Nanomaterials in thin film cells
Organic cells
Thermal PVs, quantum wells
High effic. multi-junction cells
Use of surface plasmons

Utility scale CSP

Wave
1.13

Sea cables and installation techniques

Test parks
Under surface installations
Protection for extreme conditions

Fuel cells
1.14

Commercially available, micro scale (<1kW) solution

Solid Oxide Fuel Cells
Proton Exchange Membrane cells
Molten carbonate fuel cells
Other new medium and large scale cells

Geothermal energy
1.15

Commercially available, household heat pumps

Deep drilling
Heat exchangers

2 Electricity distribution

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

Focus areas for research and development 2012-2020

Automation
2.1 Smart grid and end-user products

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

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

Microgrids => Two way energy flow for distributed energy productions
High temperature supraconductors

Substations
Equipments
2.3 Condition monitoring for condition based maintenance

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

Smart grids
2.4

3 Heat and cooling distribution

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

Focus areas for research and development 2012-2020

Automation
3.1

AMR – hourly measurement

Peak load management
Individual measuring
Separate water and heat measuring

Netwok/pipes
3.2

Improved design and materials to extend life time
District cooling

Cost reduction – new materials, new simple constructions
More simple methods for depostion
Life time prediction concepts

Substations
Equipments
3.3

Standardized components
Hourly meters
Geothermal solutions

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

4. Efficient use of electricity

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

Focus areas for research and development 2012-2020

Industry
4.1

Adjustable speed drives
Permanent magnet technology
Various process improvements

Various energy efficiency improvements using for example separation techniques
Basic processes taking energy efficiency into account

Services
4.2

Various improvements
First Green IT applications

Energy efficiency products developed for end customer use
Electric transportation
Green IT

End customers
4.3

Reduced power consumption in devices and buildings
Demand response solutions for peak shaving (in summer)

ICT and automation as tools for increasing efficiency of uninterrupted electricity use
Standardization of customer gateways and related ICT structures
Customer as a producer
Electric transportation

5. Efficient use of heat and cooling

Areas in that have been under development 1990-2012 and where exist satisfactory solutions

Focus areas for research and development 2012-2020

Industry
5.1

Energy efficiency analyses and improvements
Utilization of industrial waste heat

Integration of power/heat production with customer's processes
Utilization of industrial waste heat

Services
5.2

Energy efficiency services
Heat pumps (geothermal, air)

Competitive cooling concepts integrated with district heating
Utilization of waste heat

End customers
5.3

Energy efficiency services
Heat pumps (geothermal, air)

Competitive cooling concepts integrated with district heating
Increased use of heat - dishwashers, washing machines

Prosumers
5.4

6. New business models based on decentralization and storages

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

Focus areas for research and development 2012-2020

Energy storages
6.1

Pumping hydro power plants
Traditional heat storages in district heating
Commercial small scale batteries

Utility scale seasonal storages (electricity/heat)
New battery technologies for electricity
Chemical (methane, etc.) and material technology based storages
Various ways to use distributed energy system

Demand side management / Demand response
6.2

Traditional peak shaving technologies

Virtual power plants / Load aggregation
6.3

Fleet management of large and medium size plants

Fleet management and optimisation of a multitude of very small production units

Electric transportation
6.4

Electric transportation infrastructure
Electric vehicles
Automatic control

Smart city / Regional energy concepts
6.5

Energy system integration
Multi-carrier energy networks
Energy systems architecture

7. Market mechanisms in energy sector

Areas in that have been under development 1990-2012 and where exist satisfactory solutions

Focus areas for research and development 2012-2020

Nordic
EU
7.1
Unbundling distribution and sales
Pan-Nordic electricity exchange

Intermittent generation
Creative solutions for rem. bottlenecks
Exchange integration
Weather forecasting improvements
Extreme conditions forecasts

EU/Russia
7.2

Energy efficiency (esp. Russia)
EU-Russia market analyses and integr.

Global
7.3

Micro markets / mass production of gen units
/solar economy
Hydrogen/methane economy
New material like nano,...
International bio fuel markets
Energy and other regulations impacts into the sector

Market models
7.4

New market models / market design
- capacity vs. energy only
- balancing power solutions

8. Socio-economic, behavioral issues

Issues in that have been under development 1990-2012 where exist satisfactory situation Focus areas for research and development 2012-2020

Society 8.1	Awareness of environmental problems	Models for distributed generation; design, supply, use Sustainable cities CCS acceptance of storage Critical materials Attitudes for energy Global boundaries and energy sector
Business 8.2	Various pricing models CO2 trade	Use of real time electricity consumption in services (comfort, security, entertainment, ...) Diffusion of innovations in energy business The effects of CSR on the energy business
End customers 8.3	Regulatory steps towards improved and timely measured use of electricity	Customers active participation on energy markets and services supporting this. Increased customer awareness and engagement in efficient use of electricity - transfer of elastic loads to lower prices Constructive attitude towards changes

9. Oil refining and transportation fuels

Areas in that have been under development 1990-2012 and where exist satisfactory solutions

Focus areas for research and development 2012-2020

Raw materials for fossil fuels
9.1

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

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

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

9. Oil refining and transportation fuels

Areas in that have been under development 1990-2012 and where exist satisfactory solutions

Focus areas for research and development 2012-2020

Processes for fossil fuels
9.3

Heavy oil upgrading technology

Zero bottom oil technologies, hydrotreatment, energy efficiency.

Processes for renewable fuels
9.4

Hydrogenated vegetable oil technology, with high product quality

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

9. Oil refining and transportation fuels

Areas in that have been under development 1990-2012 and where exist satisfactory solutions

Focus areas for research and development 2012-2020

Fossil fuel products
9.5

Regulated emissions reduced.

More strict sustainability criteria.

Renewable fuels products
9.6

Hydrogenated vegetable oil for diesel with high product quality

More strict sustainability criteria, fully fungible biofuels.

Efficient use of energy in transportation
9.7

10. Bioeconomy, Circular-economy and Chemistry

Issues in that have been under development 1990-2012 leading commercial solutions Focus areas for research and development 2012-2040

Chemical
Energy
Technologies
10.1

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

Novel technologies incl. unit processes and
catalysis for oil refining.
Valorization of biomass to liquid traffic fuels and its
components.
Biogas conversion technologies.
Innovative unit operations and processes including
catalysis.
Complementary refining and value chains from
renewable raw materials to production of
high value added products
Energy efficiency of integration

Integration
between
industrial
clusters
10.2

Biorefining
technologies
10.3

Biomass degradation and fractionation.
Chemical and biotechnical methods for valorization.
Bioenergy, bio-based chemicals and biomaterials.
Total utilization of biomass.

Speciality
products
10.4

High value added bio-based products with
functional properties

Solutions for
circular-economy
10.5

Novel technologies and concepts
Innovative unit operation and
processes

11. Novel materials for energy technologies

Issues in that have been under development 1990-2012 leading commercial solutions Focus areas for research and development 2012-2040

Catalysts and catalysis
11.1

Catalysts for petrochemicals and hydrogen conversion.

Catalysts and processes for increased feedstock flexibility, higher yields, and better energy efficiency.
Catalysts and processes for renewable feedstocks.
Bioenergy technologies.
Water splitting.

Materials for solar energy
11.2

Si-based solar cell technologies and solutions based on them

Novel photovoltaic molecules and materials

Materials for Energy storage
11.3

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

Nanomaterials
Supercapacitors
High energy density, light cold sustaining materials.
Chemical energy storage technologies.
Hydrogen energy technologies, production and storage
Thermoelectric materials

Superconductivity
11.4

12. New digital solutions for energy

20. Other