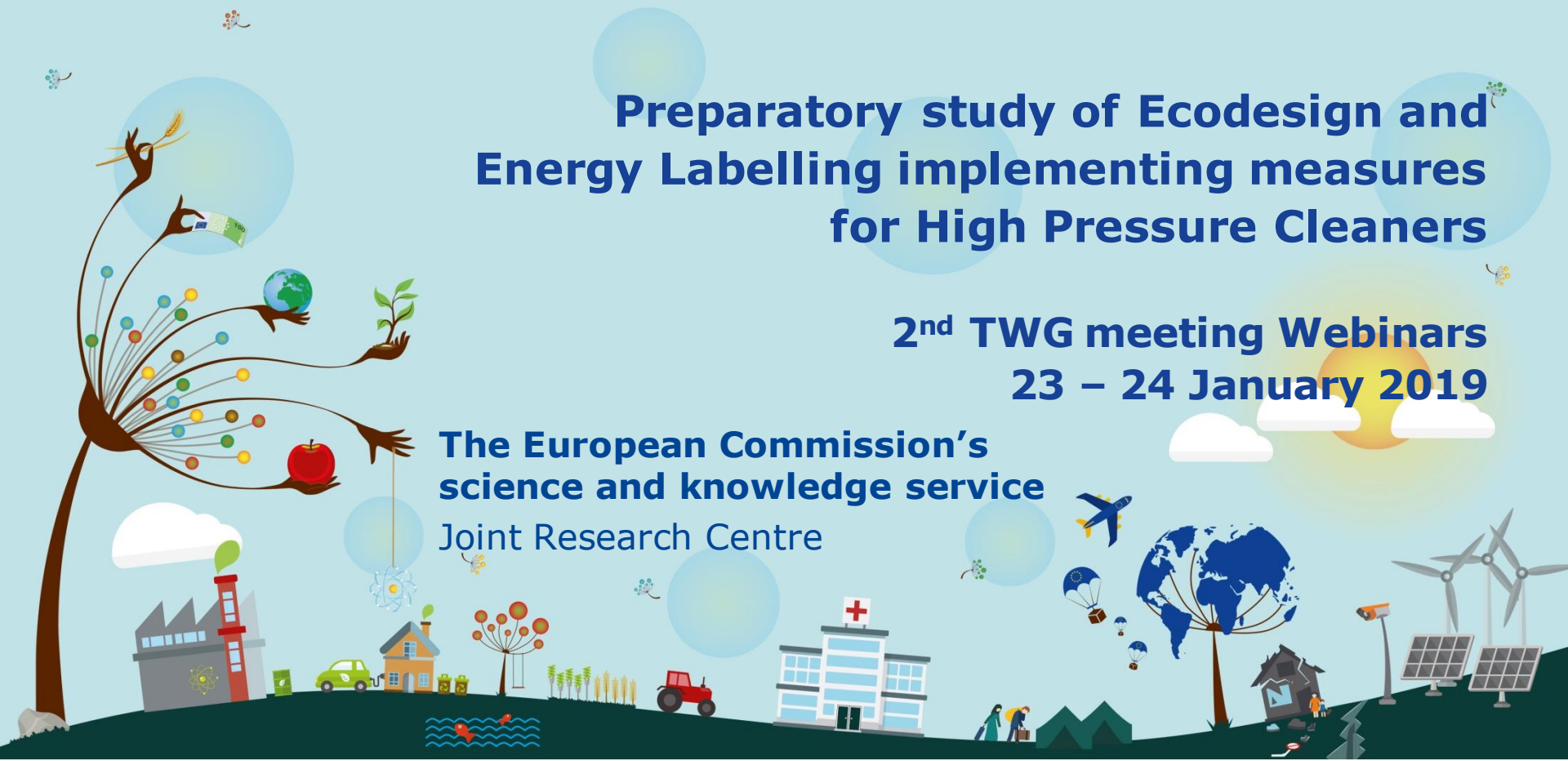
Preparatory study of Ecodesign and Energy Labelling implementing measures for High Pressure Cleaners

2nd TWG meeting Webinars
23 – 24 January 2019

The European Commission's science and knowledge service

Joint Research Centre



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Introduction
JRC and product policies

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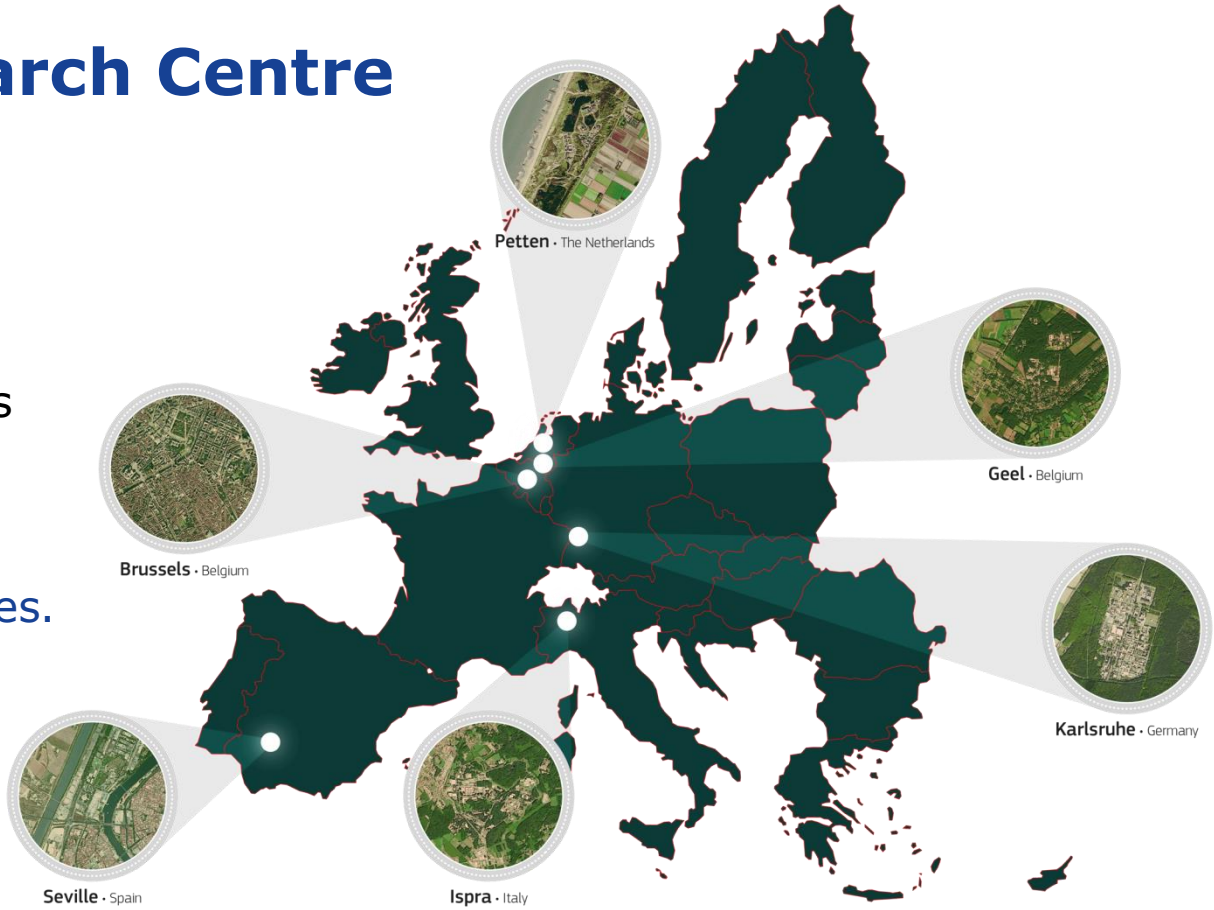
The Joint Research Centre at a glance

3000 staff
Almost 75% are scientists and researchers.
Headquarters in Brussels and research facilities located in 5 Member States.



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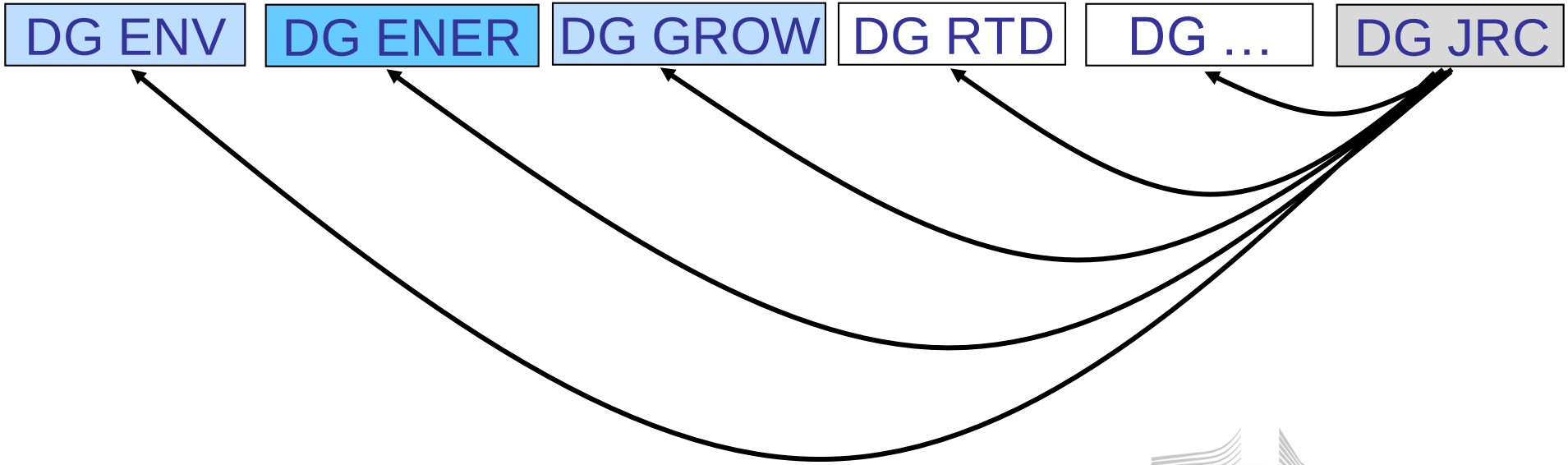
Joint Research Centre in the context of the European Commission:



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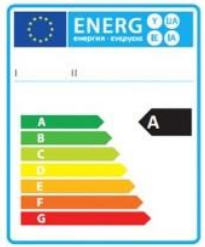
Activities in support of Product Policy

JRC supports the development and implementation of **Sustainable Product Policies**, amongst them:

- EU Ecolabel Regulation

- Green Public Procurement Communication

- **Ecodesign for Energy Related Products Directive and the Energy Labelling Directive**



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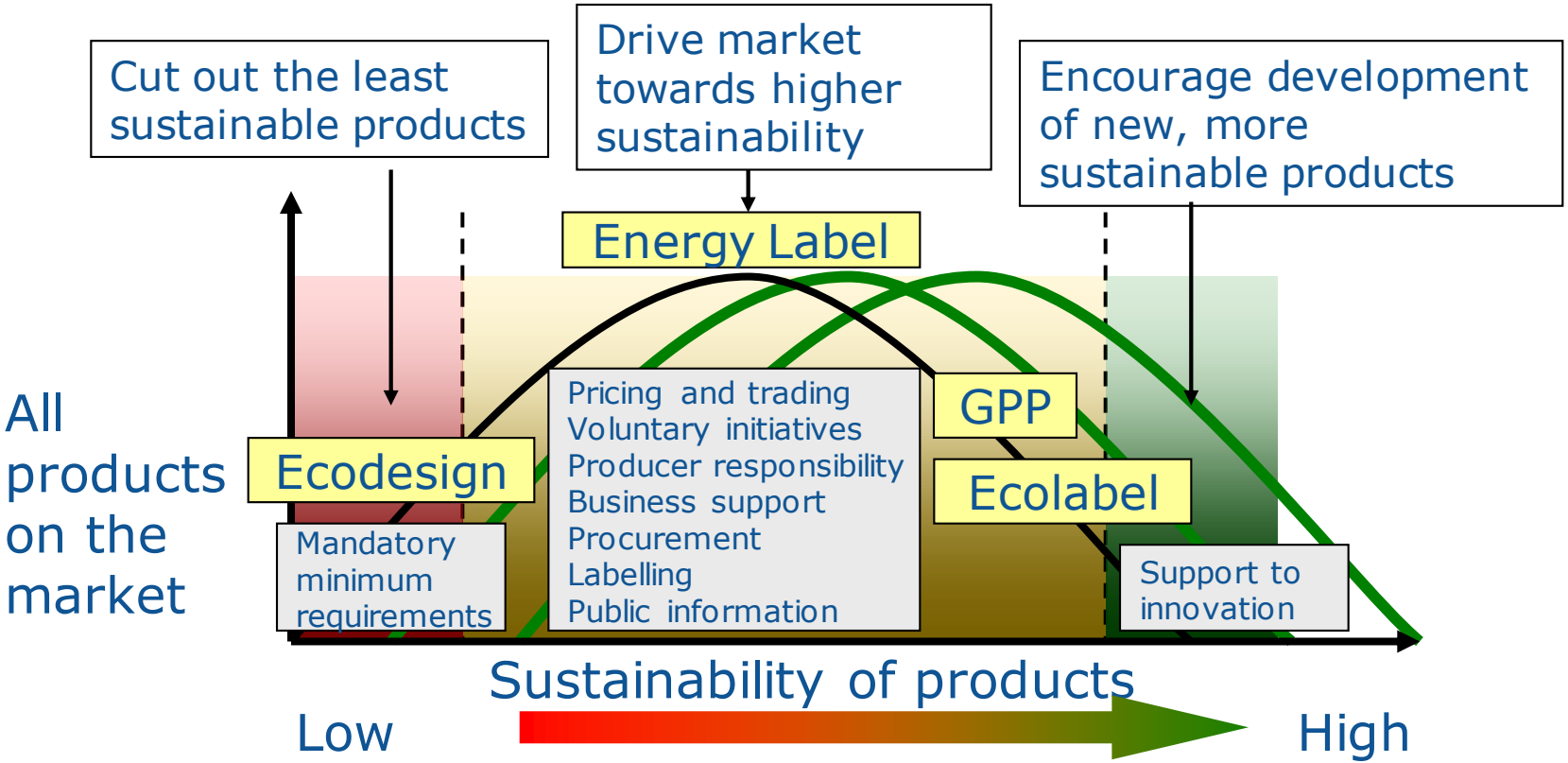

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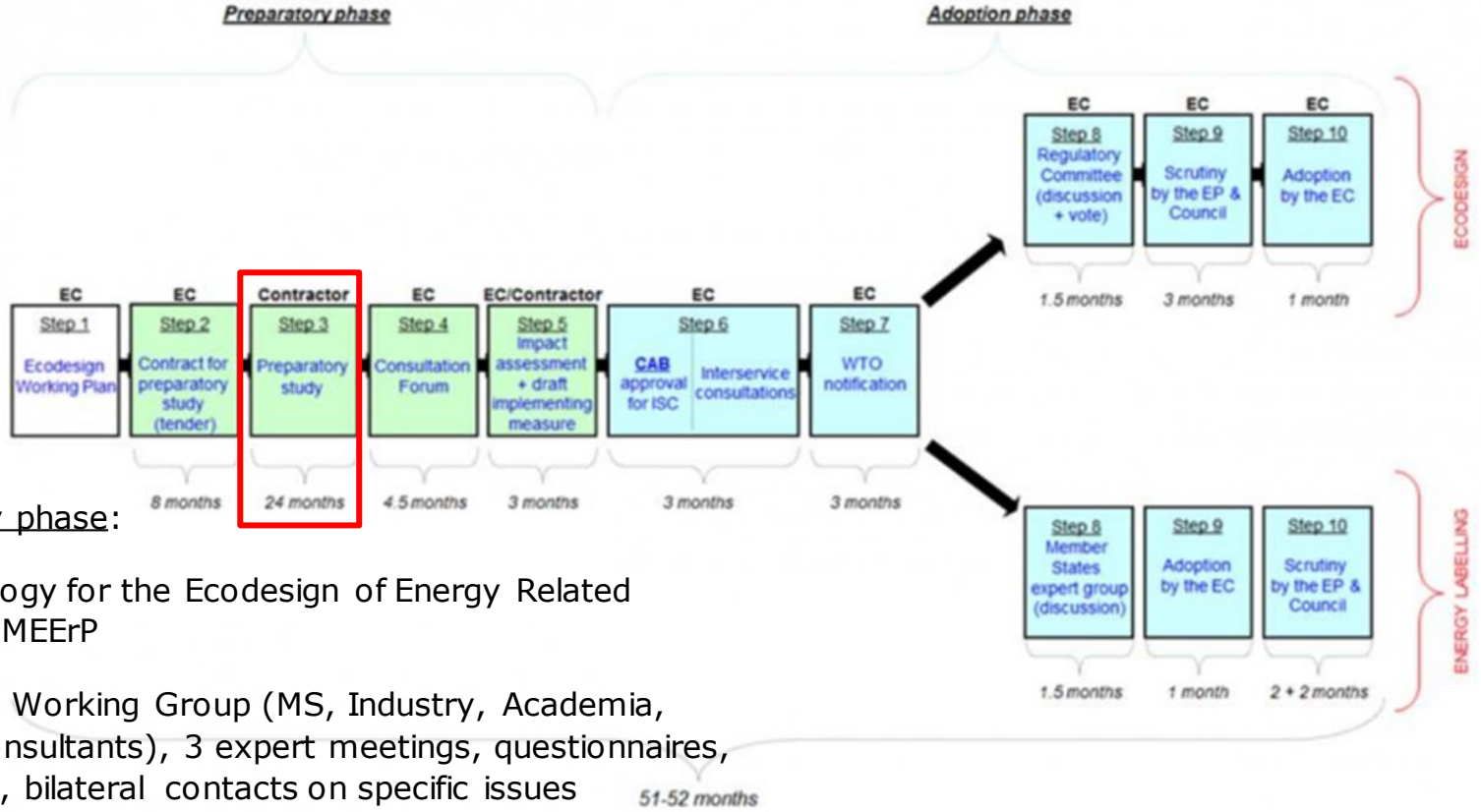
Product Policy Support

JRC support to implementation of Directive on **Ecodesign** 2009/125/EC and Regulation on **Energy Labelling** 2017/1369

- Objective → Building a **basis of information** to **support the decision-making on the policy measures to be adopted**
- Contents → **Legislative**, **Technical Economic** and **Environmental** elements
- Procedure → Independent, neutral, science-based research with **strong stakeholder involvement**

Objectives, methodology and timeline

Ecodesign & Energy Labelling process



Preparatory phase:

- Methodology for the Ecodesign of Energy Related Products MEErP
- Technical Working Group (MS, Industry, Academia, NGOs, consultants), 3 expert meetings, questionnaires, site visits, bilateral contacts on specific issues

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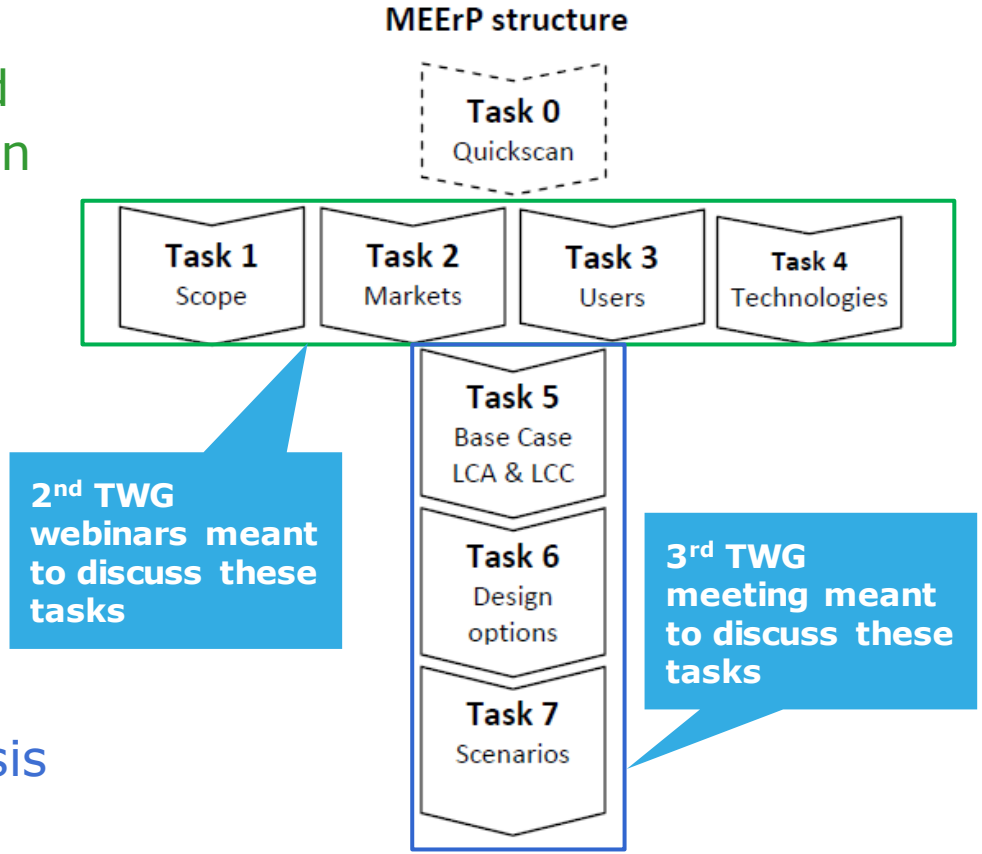
Preparatory phase

- Task 1: Product group def. and scope, standards and legislation
- Task 2: Market analysis
- Task 3: User behaviour and system aspects
- Task 4: Technologies
- Task 5: Environmental and economic assessment
- Task 6: Design options
- Task 7: Policy scenarios analysis



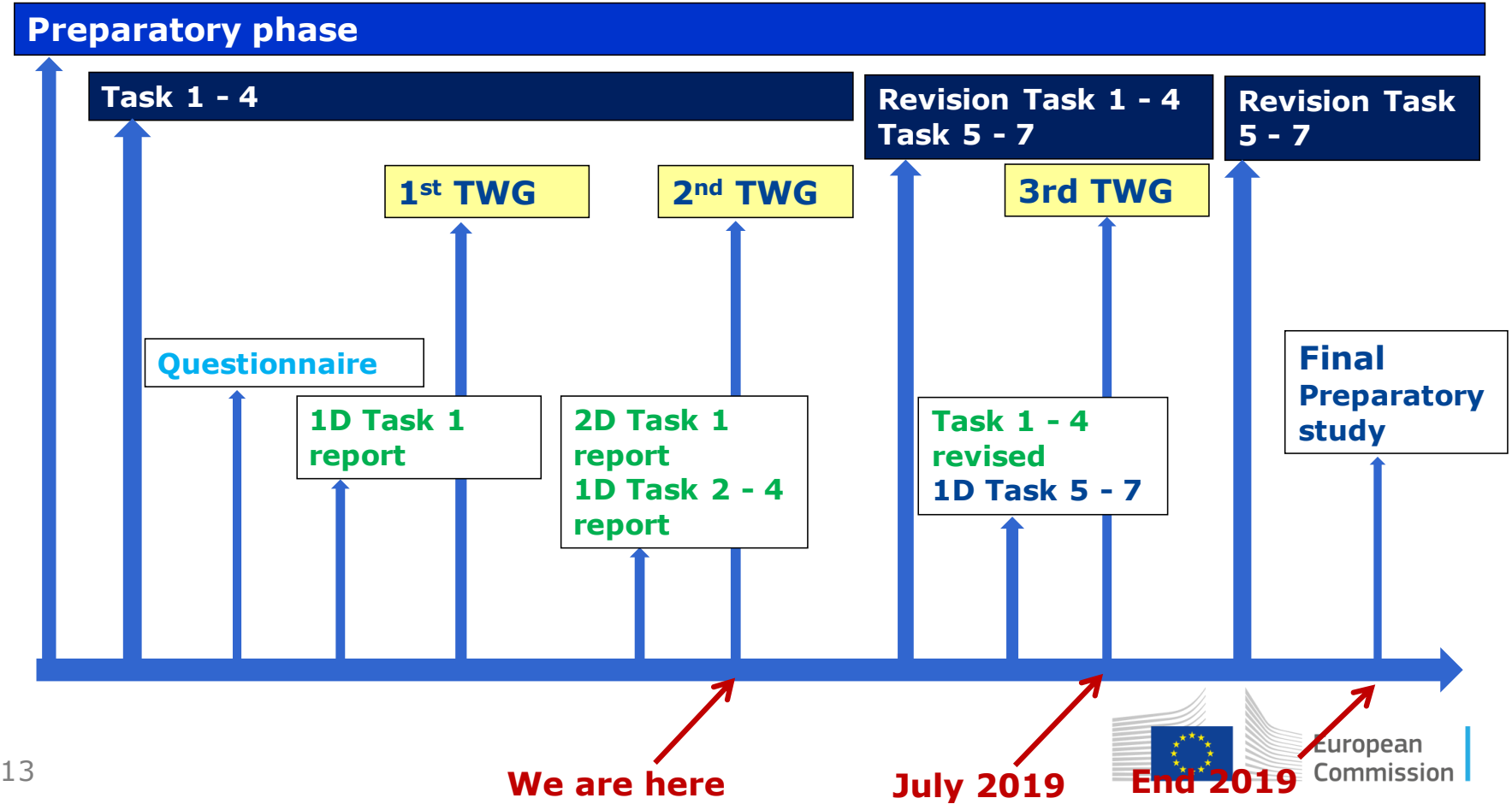
Preparatory phase

- Task 1: Product group def. and scope, standards and legislation
  - Definition product category and system boundaries
  - Test and calculation methods
  - EU and MS legislation + non-EU legislation
- Task 2: Market analysis
  - Market and stock data → needed to model the scenarios
  - Market segmentation, design and technological trends
  - Prices and rates to be used in LCC
- Task 3: User behaviour and system aspects
  - Barriers due to social, cultural or infrastructure factors
  - User-behaviour factors not represented in standards
- Task 4: Technologies
  - Technical analysis of current products in market
  - Best available and not available technologies (BAT, BNAT)

Preparatory phase

- Task 5: Environmental and economic assessment
  - Definition and description of 'base-case' → representative product category
  - Environmental and economic assessment → LCA and LCC
  - Built on the results of Task 1-4 and reference for Task 6-7
- Task 6: Design options
  - Design options + LCC/LCA → Least Life Cycle Cost (LLCC) and BAT
  - BAT = medium-term target for promotion measures
  - Between LLCC and BAT → product differentiation
- Task 7: Policy scenarios analysis
  - Suitable policy means to achieve the improvement potential
  - Scenarios quantifying the improvements vs Business-as-usual scenario
  - Estimates the impact on consumers and industry

Next steps



Task I – Product scope

Project website: http://susproc.jrc.ec.europa.eu/HighPressureCleaners/index.html

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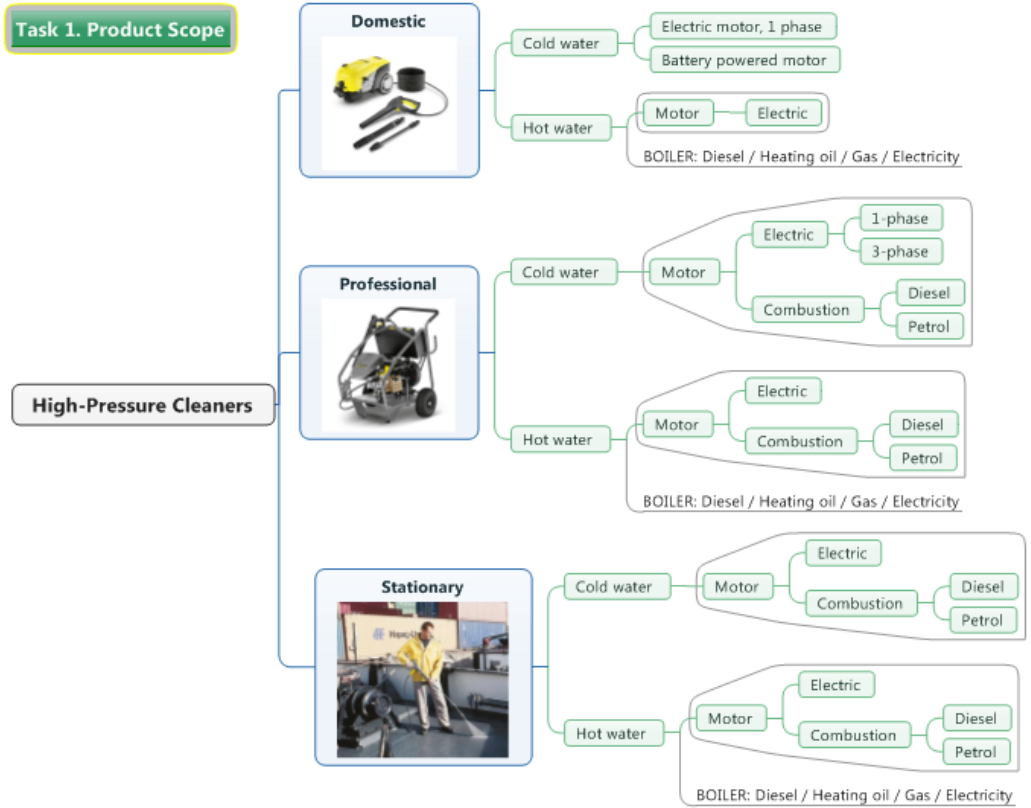
Product scope



The following power systems of the drive for the high pressure pump are covered:

- mains powered motors up to a rated voltage of 250 V for single-phase machines and 480 V for other machines
- battery powered motors
- battery and electric powered (hybrid)
- internal combustion engines;
- hydraulic or pneumatic motors.

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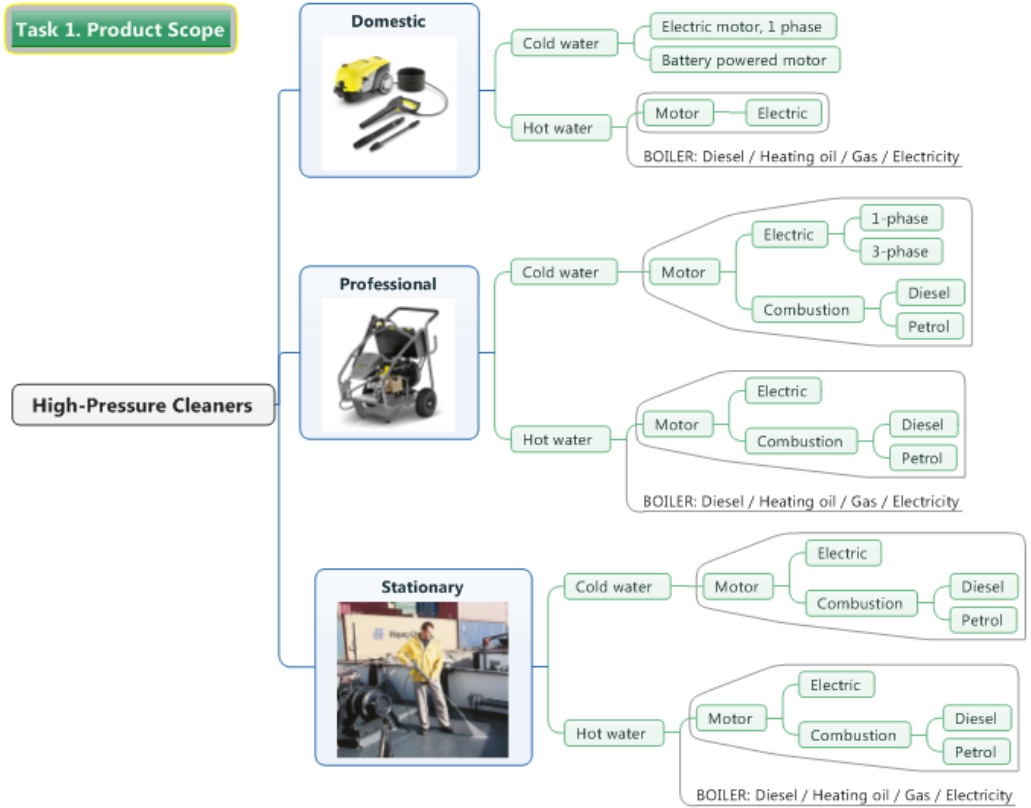
Product scope



Exclusions proposed:

- HPC having a rated pressure exceeding 60 MPa;
- Steam cleaners *per se* (i.e., steam cleaning technology only);
- Appliances for medical purposes;
- Agricultural sprayers;
- Non-liquid, solid abrasive cleaners;
- Machines designed to be part of a production process;
- Machines designed for use in corrosive or explosive environments (dust, vapour or gas);
- Machines designed for use in vehicles or on board of ships or aircraft.

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Definitions

- "**High pressure cleaner**" means a device that ejects water at high pressure (above 2.5 MPa and below 60 MPa) with the aim to remove dirt, dust, mould, etc. from a soiled surface or structure.
- "**Hot water high pressure cleaner**" means a high pressure cleaner that incorporates a water heater to raise the temperature of the input water.
- "**Domestic high pressure cleaner**" means a unit **(cold or hot**) whose maximum power does not exceed 3.3 kW, single phase, and its intended use defined by the manufacture is domestic.
- "Professional high pressure cleaner" means a unit (cold or hot water) whose power **is equal or exceed 2 kW**, and its intended use defined by the manufacture is professional or industrial. Units driven by internal combustion engines, single or three-phase electric driven and hydraulic or pneumatic motors are considered professional, and its intended use defined by the manufacture is professional or industrial.
- "**Stationary high pressure cleaner unit**" means aunit that is designed to be used at one site for a length of time but capable of being moved to another site with suitable equipment. Generally they are skid or frame-mounted with the supply line capable of being disconnected.
- "**Steam cleaner**" means a unit that are designed for steam cleaning only.
- "**Agricultural sprayer**" means: A unit that is used to apply liquid fertilizers, pesticides, or other liquids to crops during their growth cycle.

Available HPC models

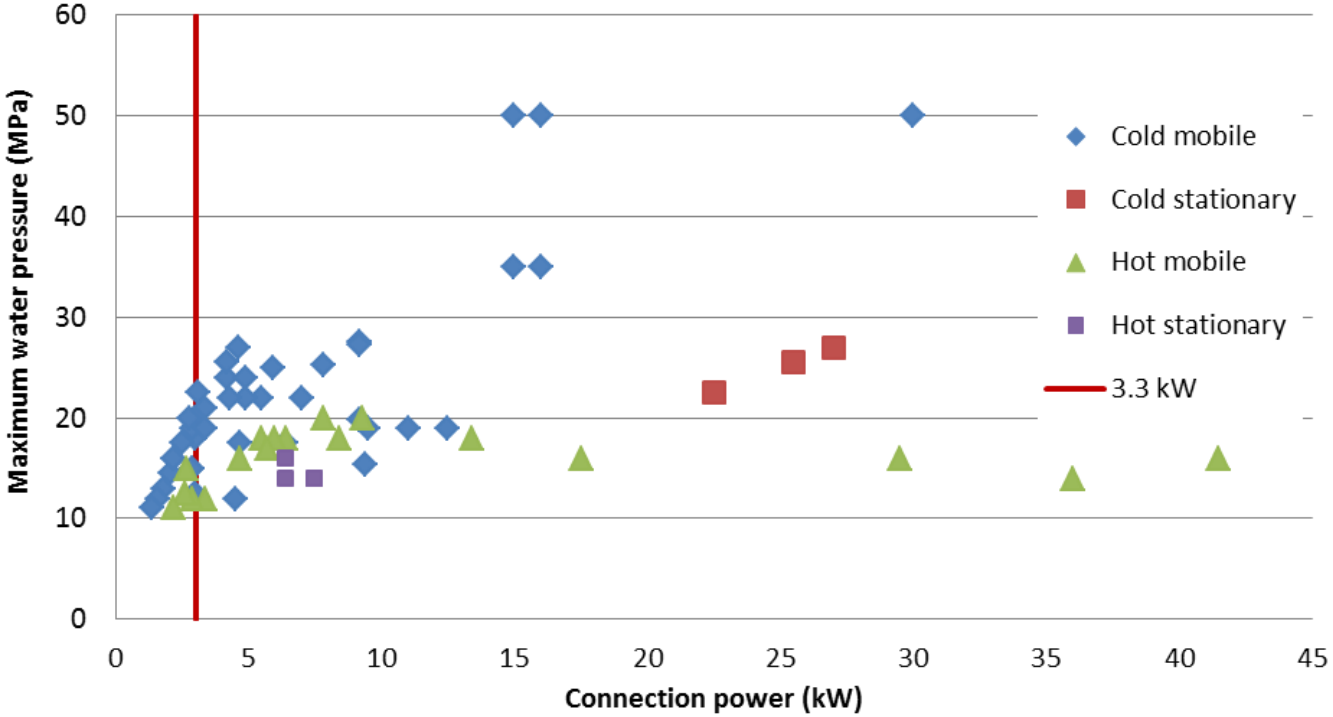
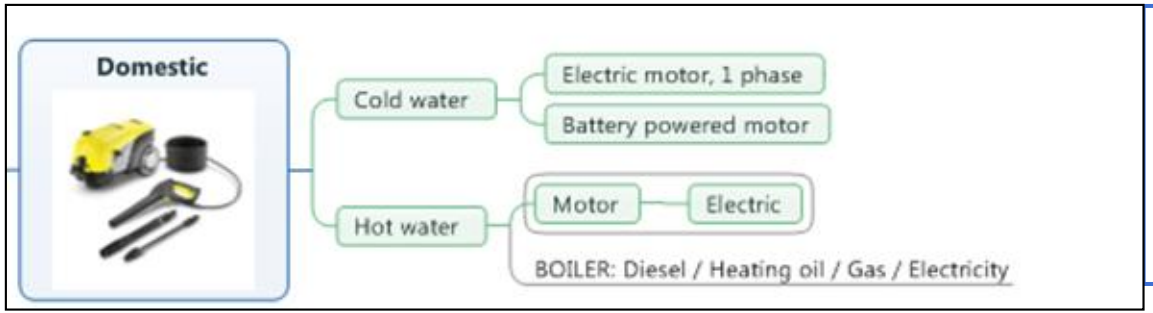


Figure: *Maximum water pressure vs connection power of various HPC models*

Intended use

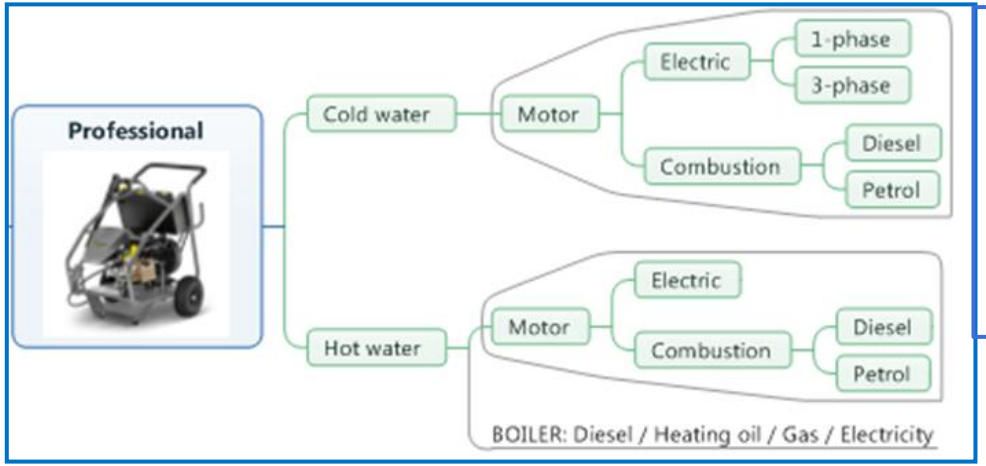
- Usage patterns are very different → **Professional products** are used much **more frequently than domestic ones**
  - **More robust in order to ensure sufficient endurance.**
  - **Designed to enable high reparability** (not the case for domestic products)
- **Intended application** (domestic or professional) is **crucial** in the design and manufacture of the HPCs

Product scope



- Power < 3.3 kW
- Hot and cold water
- **Intended use** defined by the manufacture is domestic

Overlapping between 2 – 3.3 kW → **intended use** determines the category



- Power > 2 kW
- Hot and cold water
- **Intended use** defined by the manufacture is professional or industrial

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Questions and discussion

- Do you agree with the scope proposed and exclusions?
- Are the proposed limits on pressure and definitions based on intended use appropriate to differentiate the categories of high pressure cleaners?
- Do you agree with the inclusion of stationary high pressure cleaners as a separate subcategory?
- Any other comments are very welcome!

Test standards
Legislation

Current legislation and test standards

- Safety requirements
  - **EN 60335:** *Household and similar appliances (< 35 MPa)*
  - **EN 1829:** *High pressure water jet machines (> 35 MPa)*

  Harmonised under the Machinery Directive

- Electromagnetic Compatibility
  - **EN 55014, EN 61000** *Electromagnetic compatibility*

  Harmonised under the Machinery Directive

- Acoustics
  - **EN ISO 4871, EN ISO 11203, EN ISO 3744,** *called up by EN 60335-2-79:2012*

  Annex III of Outdoor Noise Directive

Current legislation

- EU Machinery Directive
- EU Outdoor Noise Emission Directive (under revision)
- EU WEEE Directive
- EU RoHS Directive
- EU Ecodesign and Energy labelling
- Non Road Mobile Machinery Regulation
- EU Battery Directive
- Pressure Equipment Directive
- Radio Equipment Directive
- Regulation on appliances burning gaseous fuels

Test standards on performance/efficiency

IEC 62885-5 Ed. 1 Surface cleaning appliances - Part 5: High pressure cleaners and steam cleaners - Methods of measuring the performance

- IEC Technical Committee TC59 Performance of household and similar electrical appliances
- Committee Draft Vote stage (59F/340/CDV) voted in May 2018.
- Contents:
  - **Efficiency tests of oil-heated high pressure cleaners → based on the EUnited Voluntary burner efficiency label**
  - **Cleaning efficiency → *under consideration***

Test standards on performance

Cleaning efficiency or cleaning performance

- There are no current EN/IEC performance testing standards for high pressure cleaners → no harmonisation
- Manufacturers → in-house test protocols
- Test laboratories → tests on behalf of consumer organisations

- Two approaches:
  - **Pre-soiled and aged surfaces**
    → heterogeneous substrate
    → large number of test samples and time and labour-intensive test work
  - **Artificial test surfaces**
    → controlled substrate

Test methods on performance

- There may be the need of developing of a test method on cleaning efficiency within Ecodesign / Energy labelling framework
- Collaboration from stakeholders would be welcome
- Some technical parameters identified:
  - Surface material
  - Characteristics of the dirt (chemical and physical)
  - Speed and pattern of the nozzle over the surface
  - Type of nozzle
  - Water temperature
  - …

Questions and discussion

- Is there any relevant standard/legislation not identified?
- Are you aware of any standard under development on cleaning efficiency?
- Any standard under development or expected in the future that may be relevant for the study?
- Any other comments are very welcome!

Task II – Markets

Project website: http://susproc.jrc.ec.europa.eu/HighPressureCleaners/index.html

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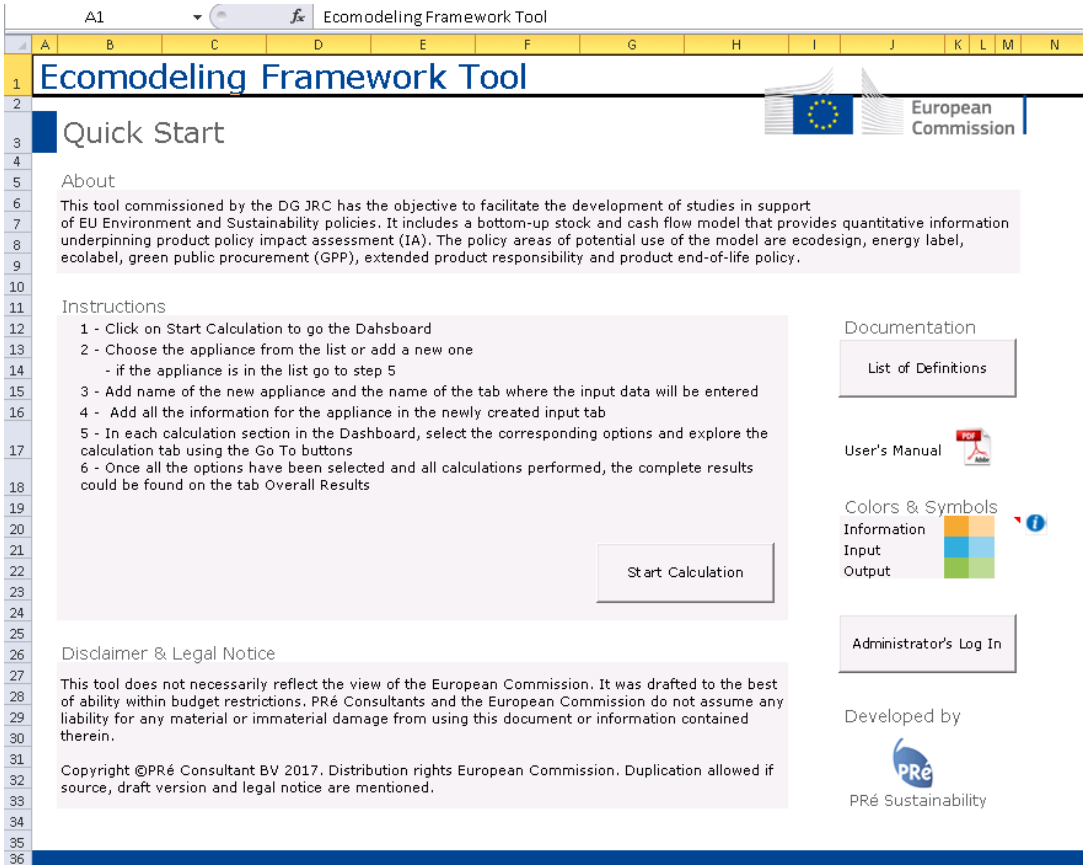
Ecomodelling tool



In-house developed tool with the objective to facilitate the development of studies in support of EU Environment and Sustainability product policies.

It includes a bottom-up stock and cash flow model that provides quantitative information underpinning product policy impact assessment (IA).

The policy areas of potential use of the model are ecodesign, energy label, ecolabel, green public procurement (GPP), extended product responsibility and product end-of-life policy.

Successful implementation at the IA of: washing machines; dishwashers; welding equipment etc

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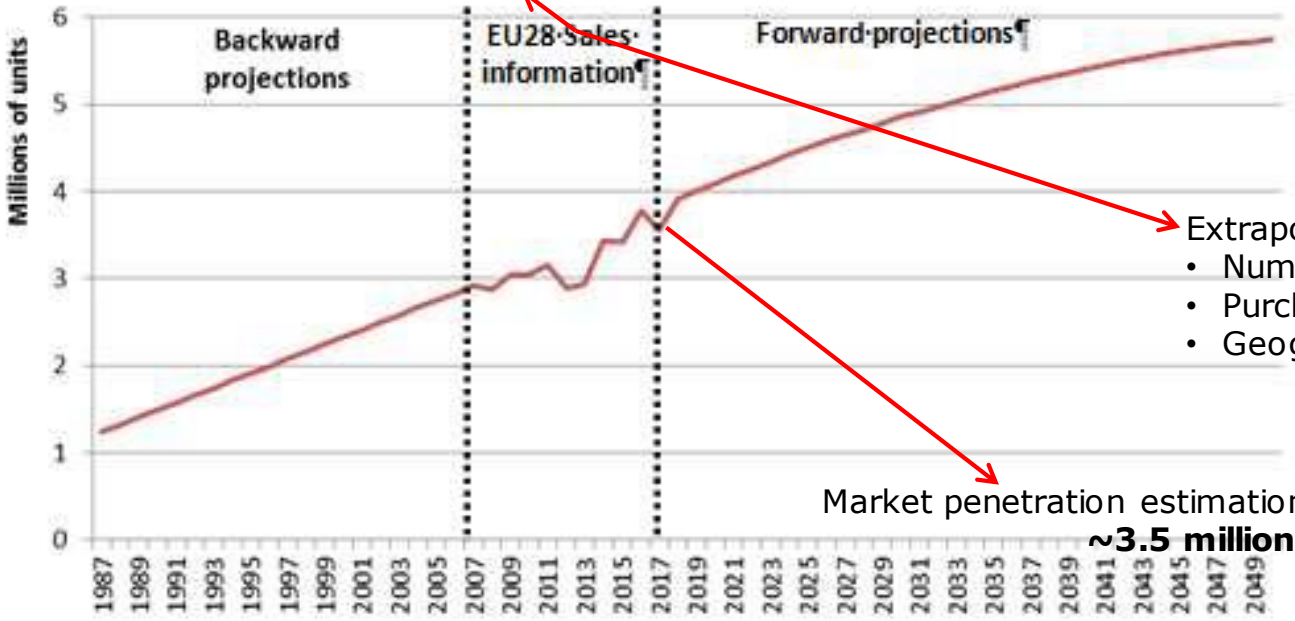
EU28 sales for domestic HPC

*Historical sales for: BE, DE, UK, FR, SP, PT, NL, IT (***~50%** of the EU28 households/ **~2.5 m units**)



Extrapolation to EU28 based on:

- Number of households per country
- Purchasing Power Standards (PPS)
- Geographical patterns

Market penetration estimation (2017 - EU28): 8.3%
~3.5 million units

Figure: *Estimated historical sales of domestic HPC for EU28 for 2007-2017 along with forward and backward projections covering in total the period 1997-2050.*

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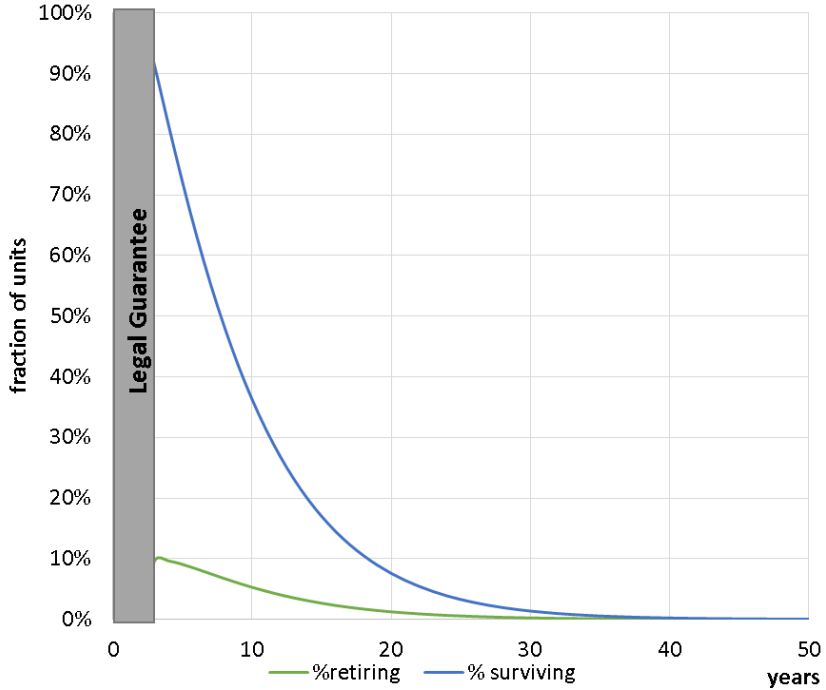
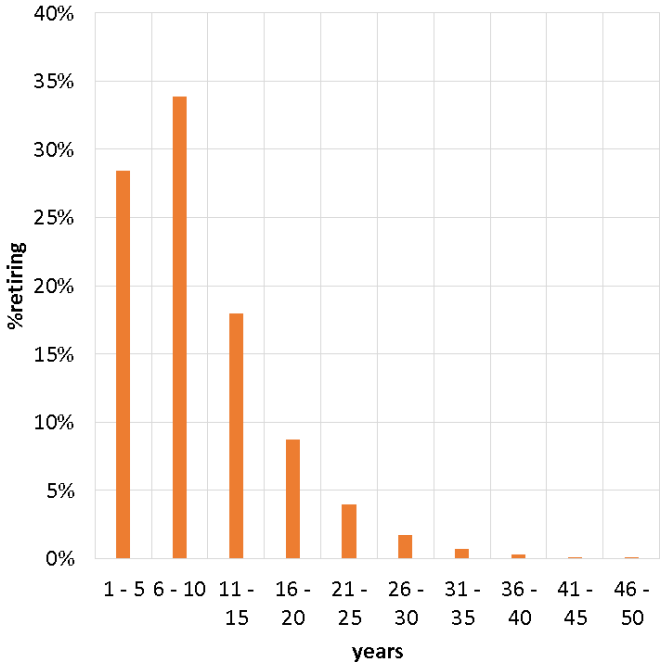
Domestic HPC lifetime calculation





Faults after the 1st year at the level of 3% (covered by the legal guarantee)
Faults after the 3rd year at the level of 9%

Minimum lifetime: 96 hours of use

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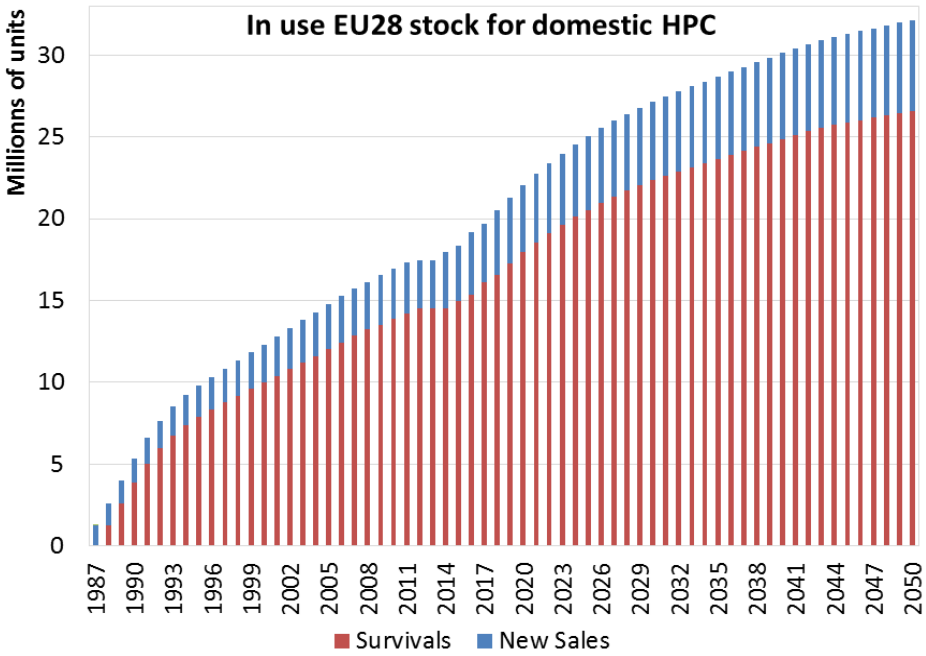
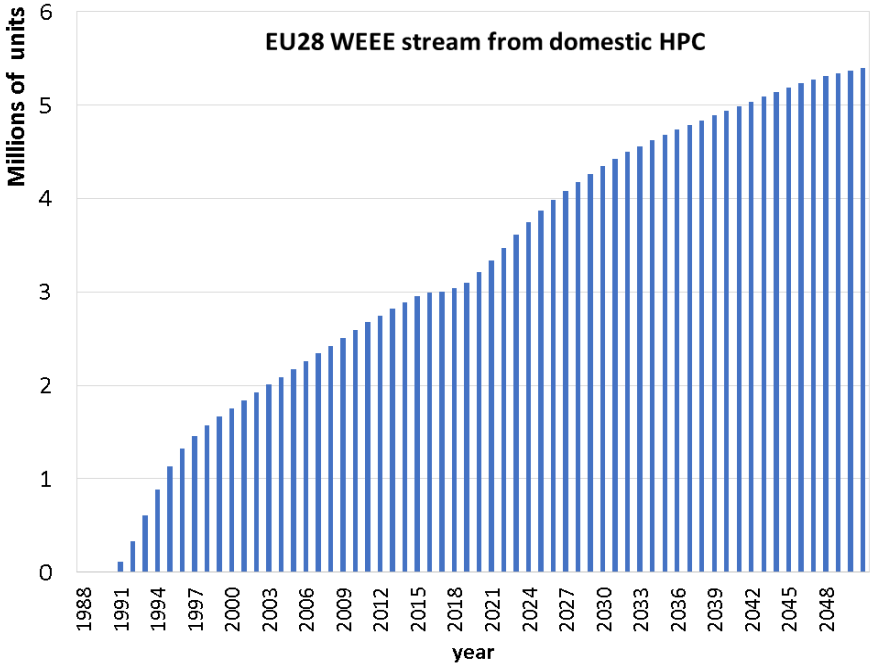
Domestic HPC stock & WEEE estimations





Figures: a) Estimated 'Survival' and 'New Sales' of domestic HPC units at EU28 level; b) Estimated WEEE fraction generated by domestic HPC at EU28 level.

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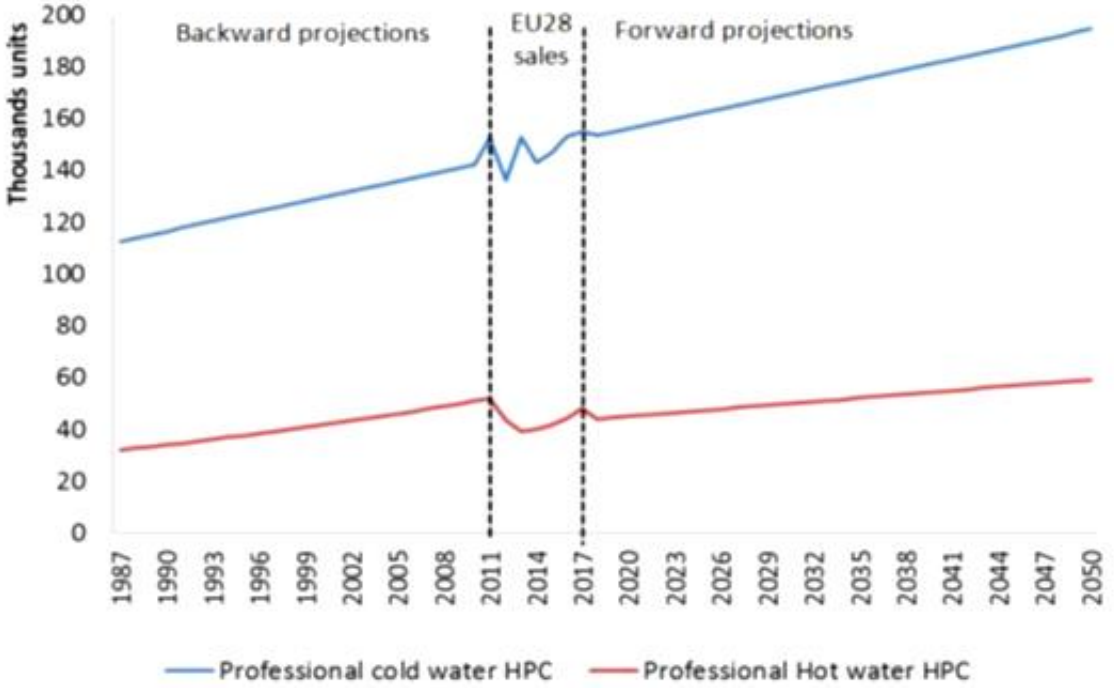
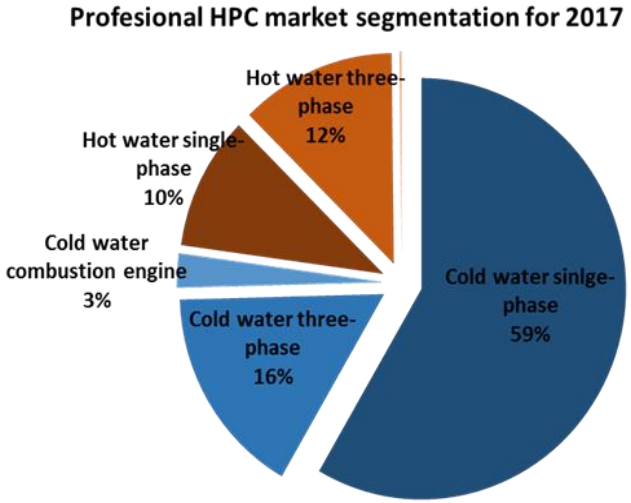
Sales estimations & market segmentation for professional HPC





Figures: a) EU28 estimated sales for cold and hot water professional HPC for 2011-2017 along with forward and backward projection covering the period 1997-2050; b) market segmentation.

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Lifetime estimations for professional HPC

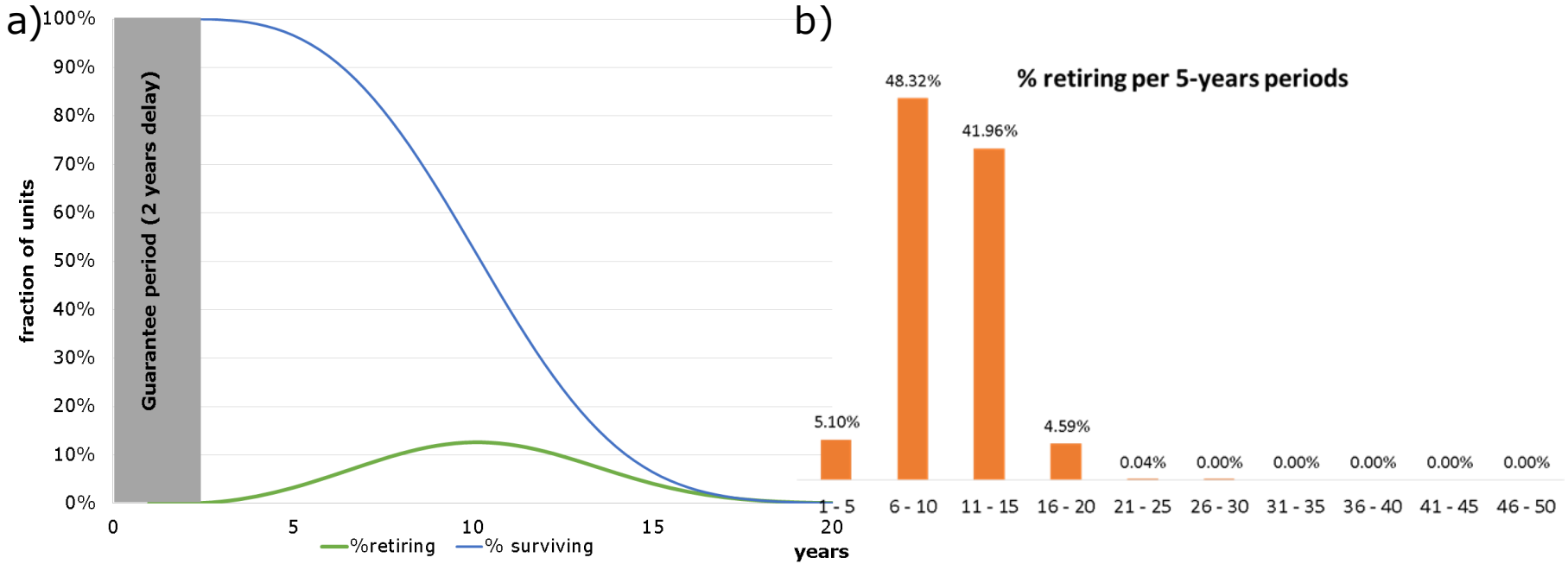

Figure: The professional HPC Weibull lifetime distribution with information on the % of retiring product and the % of survivals.

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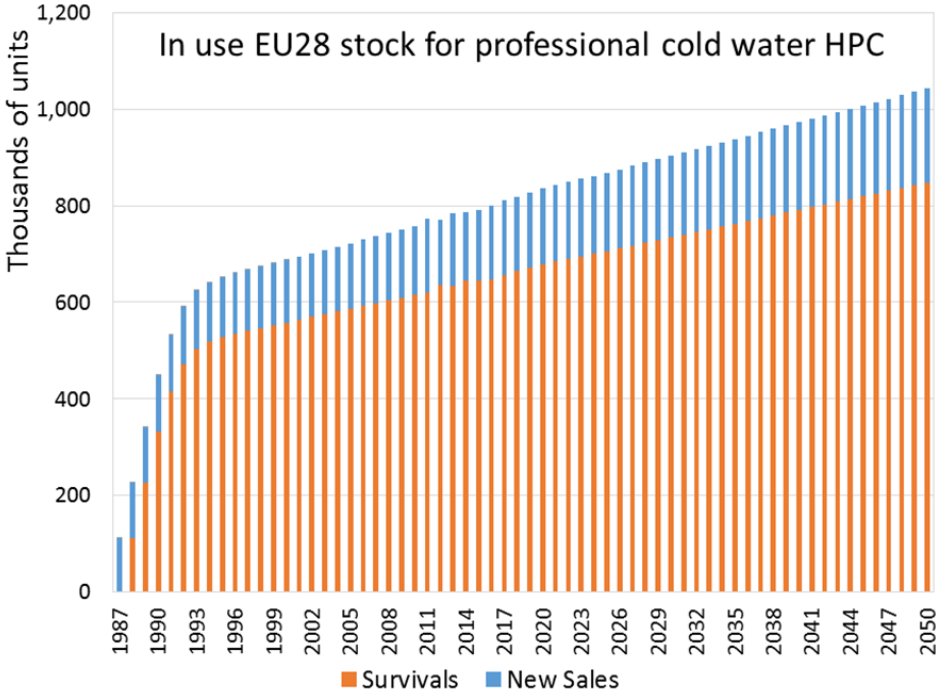
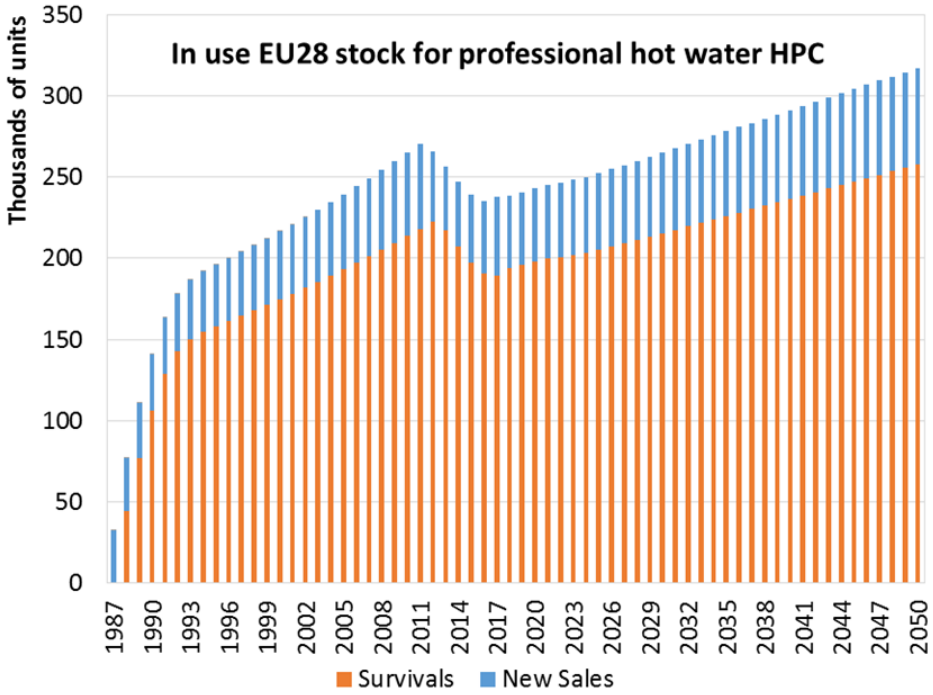
Professional HPC in use EU28 stock





* *Task 5 (LCA+LCC at unit and EU28 level) further analyse the Professional HPC categories to 1/3 phase cold water; 1/3 phase hot water and cold water combustion engine*

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Market trends (domestic HPC)

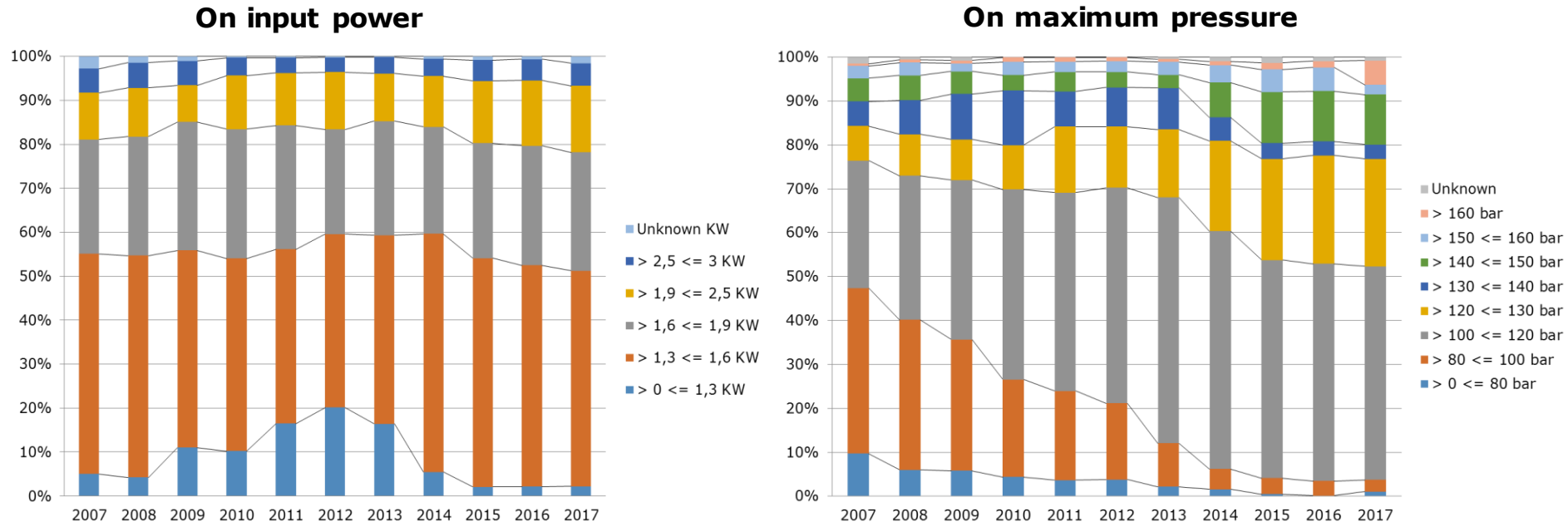

Figure: Market share (%) of a) input power categories for domestic HPCs for the years 2007-2017; b) maximum pressure

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Market trends (cold vs hot water >160 bar)

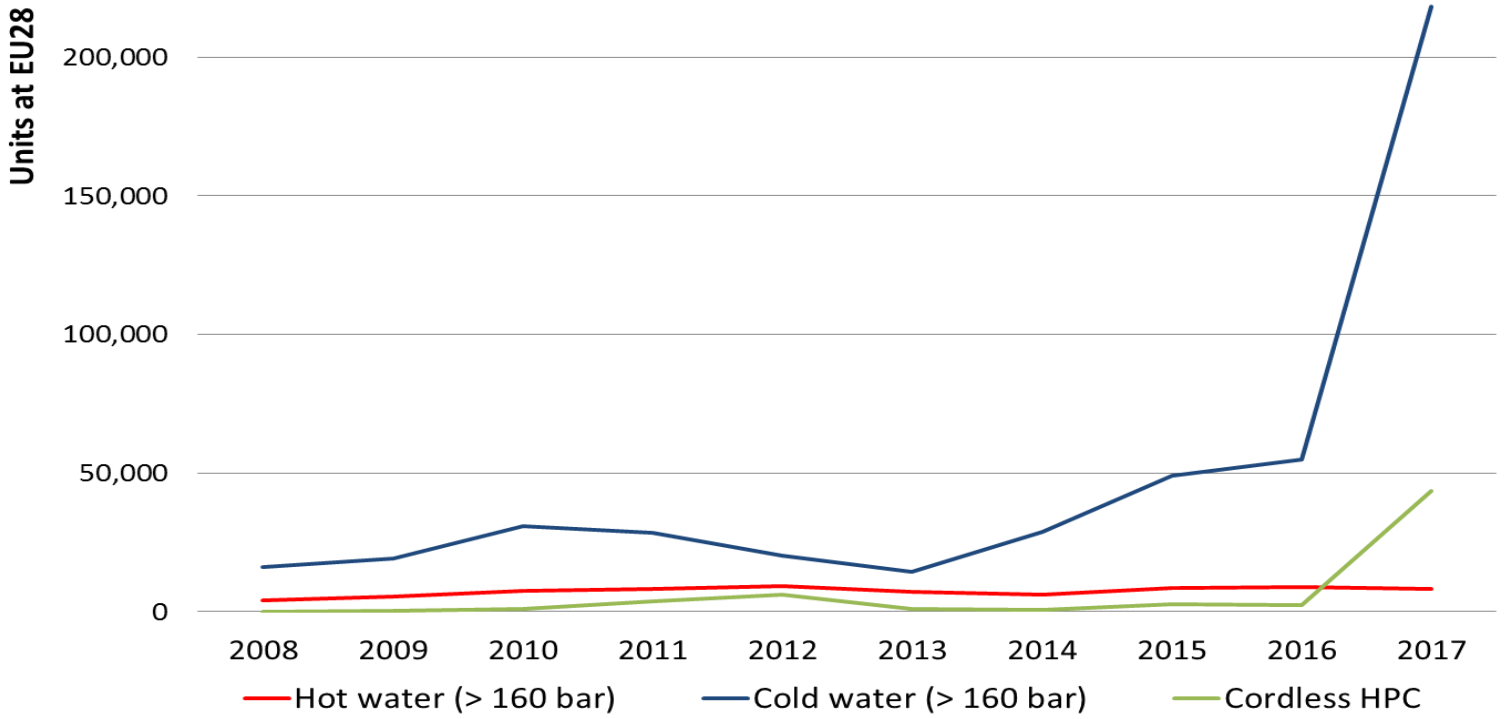

Figure: Unit sales for the period 2008-2017, hot and cold water HPCs capable of maximum water pressure above 160 bar as well as the sales of cordless HPC of low water pressure.

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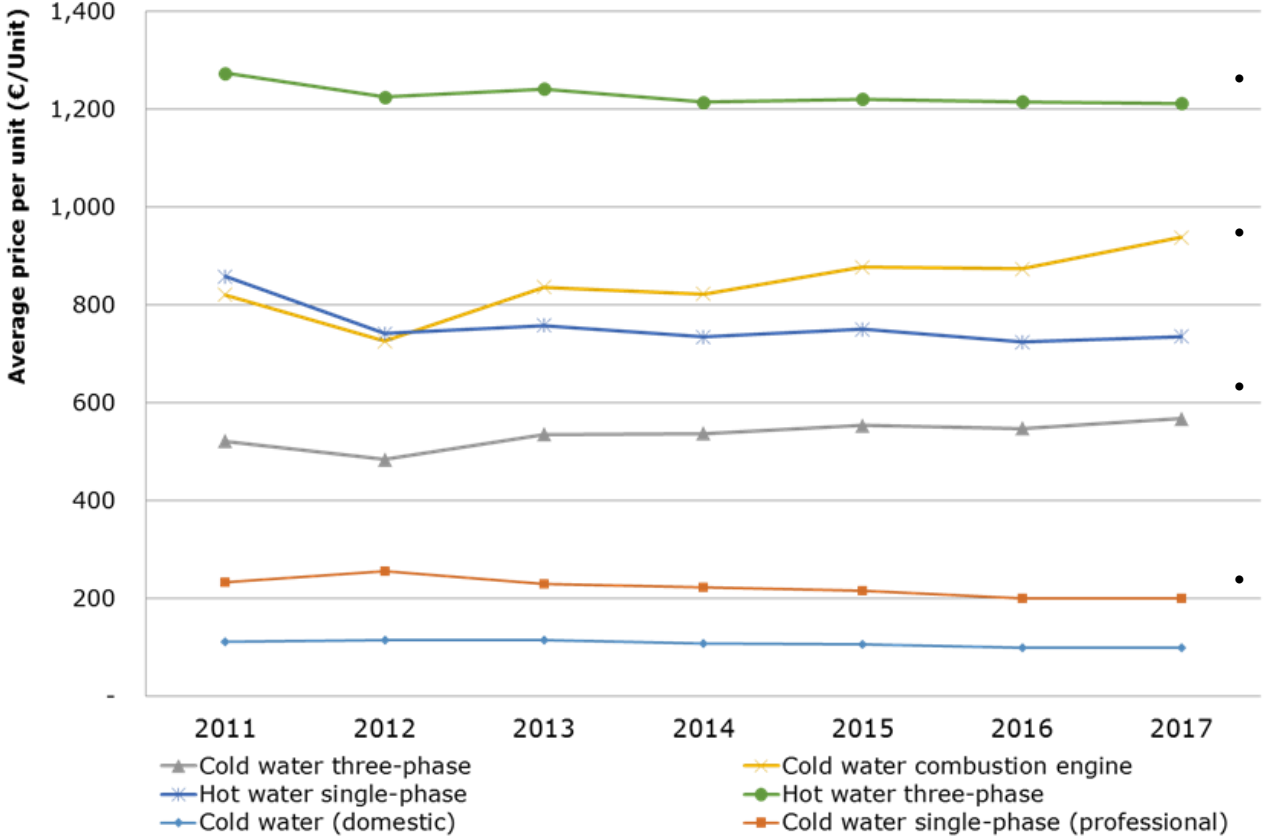
Average unit values for EU28 (2017 ref year)



- The overall value of the **domestic HPC** EU market for 2017 has been estimated at **600 million EUR**.
- The overall value of the **professional HPC EU market** for 2017 has been estimated at **120-140 million EUR**.
- **Combustion engine driven hot water HPC is a niche product** (with average price per unit at the level of **6,000 EUR per unit**).
- Single phase professional cold water HPCs have around double the average price per unit of the domestic cold water HPC units.

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Question and Discussion

- Do you have additional HPC sales information e.g. countries in east Europe?
- Do you agree with the exclusion from the product scope of the hot water combustion engine HPC? (niche product – <1000 units sales/year)
- Any other comments are very welcome!

Task III – User behaviour and system aspects

Project website: http://susproc.jrc.ec.europa.eu/HighPressureCleaners/index.html

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Data collection

- Technical data and **data on user behaviour** such as annual usage → from some of the manufacturers and associations
- Data on **laboratory tests** of various models of domestic HPCs from a stakeholder
- **Reviews, test results and advice guides** of HPCs → public data from the consumer organisation Which? (UK)
- **Technical specifications data** of domestic and professional HPCs → public web sites of manufacturers → 160 models

System aspects use phase

- **Cleaning task:** patio floor, façade, vehicle surface, etc.
- **Cleaning factors and product usage**
  - Water flow and pressure
  - Accessory (type of nozzle and cleaning attachment)
  - Cold or hot water (where relevant)
  - Detergent and dosage
  - Usage pattern (distance and angle to surface, speed of movement, etc.)
- **Frequency of use**
- **Time in idle, standby and off modes**

Cleaning factors

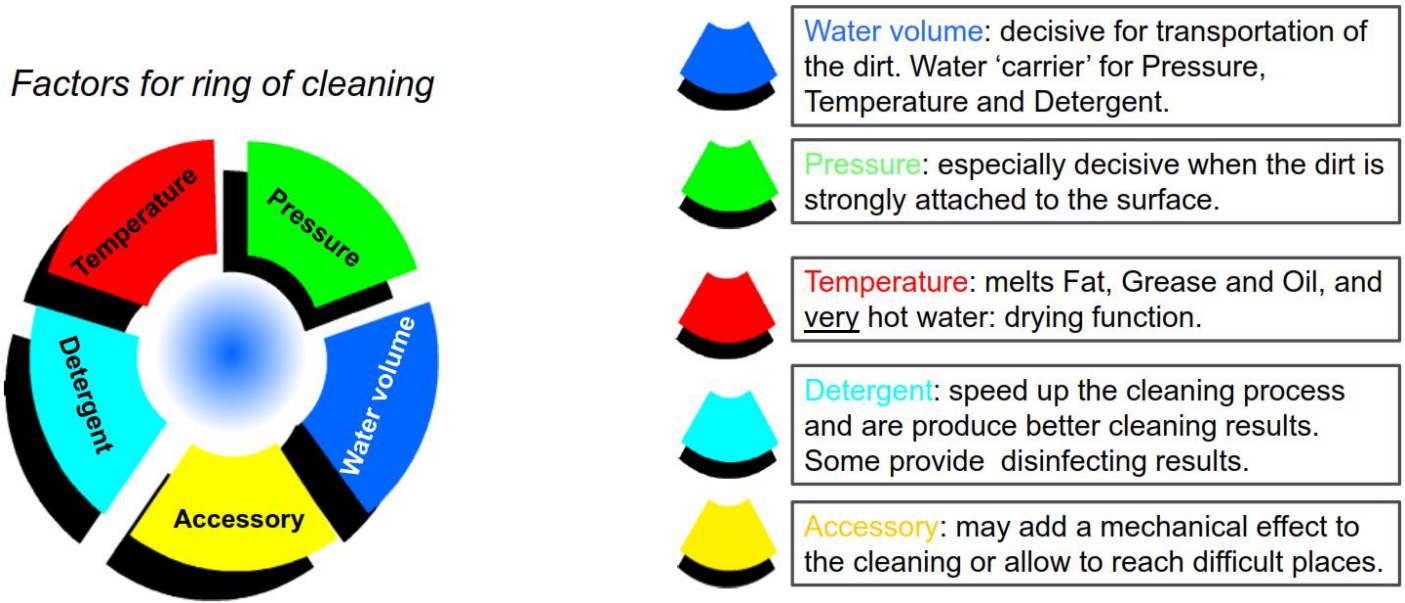
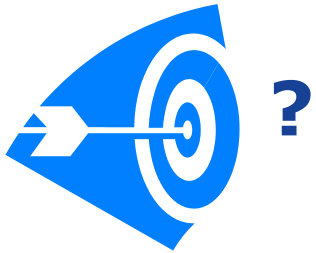


Figure 1: Cycle with the basic factors for cleaning. Provided by the manufacturer Nilfisk.

Frequency

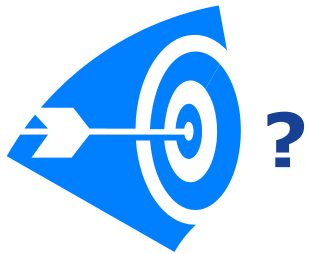
Type of HPC	Annual usage Range and average, hours/year
Cold water domestic HPC	2-8, average: 5
Cold water professional HPC	100-200, average: 150
Hot water professional HPC	100-200, average: 150
Cold water stationary HPC	100-200, average: 150
Hot water stationary HPC	100-200, average: 150
Car washer stationary HPC	2000-8000, average 5000 cars / year

- Based on **stakeholders input**
- **High impact on results** → range of usage times and the average for further sensitivity analysis.
- Professional and stationary→ same usage pattern assumed



Hot water and average load motor

- **Hot water HPCs** → Average pressure ~ 20% lower than for cold water machines → Real need for hot water for a substantial part of the uses
  - Assumption: 50% of uses are with hot water.
- Domestic **HPCs using externally heated water** → availability of hot water taps outside is limited
  - Assumption: the use is very low (5%)
- Average load motor: from tests provided by a stakeholder
  - Assumption: maximum connected load reduced with 10%



Annual energy consumption electric driven HPC

Type of HPC	Average load motor kW	Annual usage Range and average Hours/year	Annual electricity consumption Range and average kWh/year	Annual fuel consumption Range and average kWh/year
Domestic cold water	1.8	2-8, average: 5	4-14, average: 9	
Domestic hot water	1.8	2-8, average: 5 (50% with hot water)	4-14, average: 9	30-118, average: 74
Professional cold water 1-phase	2.9	100-200, average: 150	294-587, average: 440	
Professional cold water 3-phase	7.7	100-200, average: 150	766-1533, average: 1150	
Professional hot water 1-phase	2.5	100-200, average: 150 (50% with hot water)	254-507, average: 380	1801-3603, average: 2702
Professional hot water 3-phase	6.7	100-200, average: 150 (50% with hot water)	674-1348, average: 1011	3545-7090, average: 5318
Professional hot water 3-phase, electric heater	5.0	e: 150 ater)	1695-3390, average: 2543	
Stationary cold water	13.9	100-200, average: 150	1385-2770, average: 2078	
Stationary hot water	6.8	100-200, average: 150 (50% with hot water)	683-1366, average: 1024	3888-7776, average: 5832
Car washer stationary HPC	13.9	2000-8000, average 5000 cars / year	745-2980, average: 1863	

Heating oil 2.45 kg/h

Heating oil 2.99 kg/h

Heating oil 5.88 kg/h

Electric heater 24 kW

pean
mission

Annual energy consumption ICE driven HPC

Type of HPC	Fuel consumption motor kg/h	Fuel consumption heating kg/h	Annual usage Range and average Hours/year	Annual fuel consumption Range and average kWh/year
Professional cold water combustion	2.87		100-200, average: 150	3457-6914, average: 5185
Professional hot water combustion	2.67	5.50	100-200, average: 150 (50% with hot water)	6537-13074, average: 9805

Annual water consumption

Type of HPC	Average in-use water flow l/h	Annual usage Range and average Hours/year	Annual water consumption Range and average m^3/year
Domestic cold water	383	2-8, average: 5	1-3, average: 2
Domestic hot water	450	2-8, average: 5	1-3, average: 2
Professional cold water 1-phase	540	100-200, average: 150	54-108, average: 81
Professional cold water 3-phase	992	100-200, average: 150	99-198, average: 149
Professional cold water combustion engine	687	100-200, average: 150	69-137, average: 103
Professional hot water 1-phase	463	100-200, average: 150	46-93, average: 69
Professional hot water 3-phase	969	100-200, average: 150	97-194, average: 145
Professional hot water 3-phase, electric heater	646	100-200, average: 150	65-129, average: 97
Professional hot water combustion engine	706	100-200, average: 150	71-141, average: 106
Stationary cold water	2528	100-200, average: 150	253-506, average: 379
Stationary hot water	889	100-200, average: 150	89-178, average: 133
Car washer stationary HPC	68 l/car	2000-8000, average 5000 cars/year	136-544, average: 340

Energy consumption of hot water externally heated

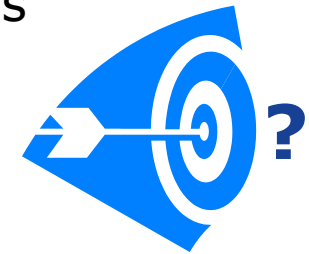
- Cold water HPCs → connected to hot instead of cold water from a building's sanitary hot water system
- Cold water supply T = 10°C → heated to 60°C
- Water heater and energy used to heat the water
  - 60 % natural gas water heaters and combi boilers
  - 40 % electric storage and instantaneous heaters

Preparatory Study on Ecodesign of Water Heaters

Type of HPC	Proportion of hot water externally heated (%)	Annual heated water consumption Range and average m^3/year	Natural gas consumption Range and average kWh/year	Electricity consumption Range and average kWh/year
Domestic cold water HPC	5	0.038-0.153, average: 0.096	2-7, average: 4	1-4, average: 2
Professional cold water 1-phase	5	2.701-5.402, average: 4.052	118-236, average: 177	63-126, average: 94
Professional cold water 3-phase	5	4.958-9.915, average: 7.436	216-432, average: 324	115-231, average: 173

Use of detergents

- Maximum detergent dosage in litres/min according to HPCs manufacturers information
  - 40 (only 4 domestic) of the 160 HPCs provide this info
  - Average → 5.5% max flow
- Proportion using detergent in domestic units
  - 1/3 of the usage of HPCs is car, motor bike and bike cleaning
  - 2/3 of this specific use is with added detergent
  - = about 20% of all pressurized water is with added detergent
  - Domestic hot water units are assumed to consume half detergents than cold water
- For professional users → about 10 % of all cleaning tasks are with added detergent.
- For car washers → 30% of the total water consumption is with added detergent



Annual detergent consumption

Type of HPC	Annual water consumption Range and average m^3/year	Proportion using detergent %	Annual detergent consumption Range and average l/year
Domestic cold water	1-3, average: 2	20	8-34, average: 21
Domestic hot water	1-3, average: 2	10	4-17, average: 11
Professional cold water 1-phase	54-108, average: 81	10	297-594, average: 446
Professional cold water 3-phase	99-198, average: 149	10	545-1091, average: 818
Professional cold water combustion engine	69-137, average: 103	10	378-756, average: 567
Professional hot water 1-phase	46-93, average: 69	10	254-509, average: 382
Professional hot water 3-phase	97-194, average: 145	10	533-1066, average: 800
Professional hot water 3-phase, electric heater	65-129, average: 97	10	355-711, average: 533
Professional hot water combustion engine	71-141, average: 106	10	388-776, average: 582
Stationary cold water	253-506, average: 379	10	1391-2781, average: 2086
Stationary hot water	89-178, average: 133	10	489-978, average: 733
Car washer stationary HPC	136-544, average: 340	100	2244-8976, average: 5610

Energy and water per functional unit

- Need of measure **energy and water consumed per functional unit** → cleaning of one square meter of soiled surface → reflect the performance of the HPC in terms of water and energy consumption
- Define a number of **different surfaces** with **different kind of soils** and define a certain cleaning pattern
- Define **potential variables in HPC usage** that could affect the result e.g. type of nozzle, distance and angle of nozzle, speed over the surface, temperature, detergent, etc.
- **Alternative**: potential cleaning performance based on **measurement of HPC output/input parameters**: jet force, flow and pump power → approximation of the cleaning impact the HPC is capable

Test methods currently available

- **Intertek USA** → *cleaning power index* from a number of factors: System force, impact force, and a spray pattern shape factor

- **Intertek UK** and other laboratories → uses *defined test surfaces* by painted insulation panels with *matt black paint* (simulating soil) applied in a standardised way so the soil level is consistent

- **Which?** → several *different types of surface* including concrete, block paving, paving slabs, and softwood decking. The surfaces are consistently and heavily soiled.

Product life influenced by user behaviour

- **Behavioural lifetime:** number of *years until the device is replaced for other reasons than technical failure* e.g. due to new features, upgrading to a more powerful model or just wanting a new model.
- Very little information → Belgian study identified the HPC penetration in Belgian household to be 39 % in 2015, where the households with HPC each **had 1.1 in average**.
  - **Some households had one or several older HPCs, which probably was not in use**
- The study further found that defected HPCs were not always disposed and might have been counted as in use

Best practices in user behaviour

Purchase:

- *Identifying* properly the **cleaning tasks** to be covered by an HPC → assistance from consumer organisations (magazines, web sites, counselling, etc.), shops, neighbours, etc.
- *Identifying* **right size, features, technical parameters** (e.g. pressure, water flow, cold / hot water, detergent use, weight, noise, independency of water and electricity supply system)
- *Identifying* **needed accessories** for the cleaning tasks, **repair and maintenance availability** and consideration of total costs of ownership
- *Considering alternatives to* purchase such as neighbouring or community sharing, rental, leasing etc., if available

Best practices in user behaviour

Use:

- **Proper training** in using the HPC including reading the manufacturer's manual
- Using the *least resource demanding setting* e.g. cold water with no detergent and **accessories best suited** for the cleaning purpose
- Proper **preparation of surfaces** to be cleaned
- Using the HPC only when *other cleaning methods* such as water hose are not sufficient or would require larger amounts of water
- Proper handling of the HPC after use according the manufacturer's instruction e.g. by emptying the pump
- **Frequent maintenance**

Questions and discussion

- Do you have additional information on user behaviour parameter that may influence the environmental impacts along the life cycle?
- How these user behaviour parameters are or can be reflected in test methods?
- Any other comments are very welcome!

Task IV - Analysis of technologies

Project website: http://susproc.jrc.ec.europa.eu/HighPressureCleaners/index.html

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Domestic HPC – general description

Parameter	Parameter value range	Comments
Power	1200-3000 W	Rated power but usually just stated as unit 'power'
Pressure	9-18 MPa	Stated Maximum or Working Pressure
Flow rate	4-9 l/min (240-540 l/h)	Stated Maximum Flow Rate
Weight	2-18 kg	Can be stated with or without accessories
Fixed jet	Standard	Entry level products often provide only one fixed nozzle as standard
Variable fan jet	Standard/optional	Approx. 70% of the models offer as standard
Rotating jet	Standard/optional	Approx. 70% of the models offer as standard

- Segmented by ***power and pressure*.**
- Range of defined ***cleaning tasks*** → differentiated via **accessories**
- Some include indication of ***cleaning performance*** in the form of *cleaned area per time*.

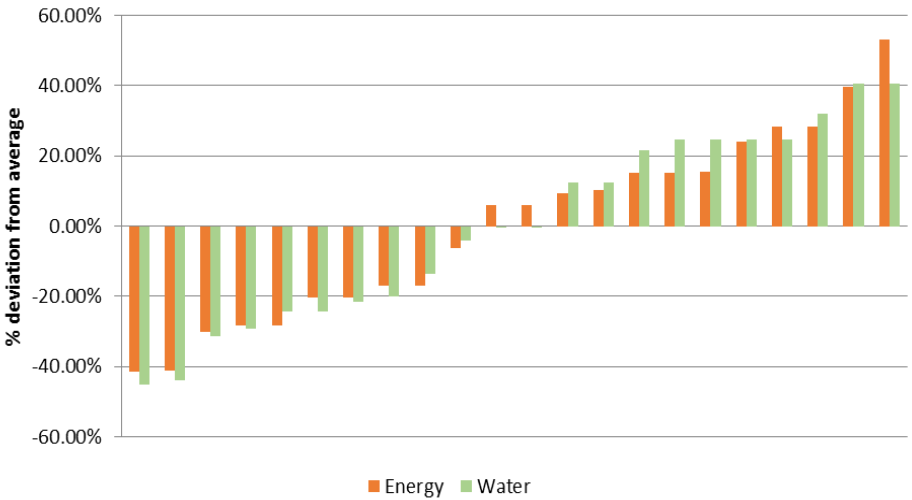
Professional HPCs – compared to domestic models

Typical design changes include:

- **Pumps** → Triplex design, crankshaft driven, *higher quality and better wear-characteristic materials* such as ceramic pistons.
- **Motors** → *Low speed* motors with *improved cooling* and more *advanced controls*
- Larger and *stronger wheels* , provision of a third wheel (or forth) on horizontal models to *improve manoeuvrability*.
- *More robust* lances and cleaning tools
- *Improvements to operating flow* (reduced vibration) and *reduced kick-back* when operating trigger to reduce operator fatigue

Domestic HPC – water and energy

Real water and energy consumption of the domestic HPCs using standard nozzle



- 7 out of 10 consume at least 20% less water and energy
- 2 reach the best performance (40% less water and energy than the average)

- 8 out of 12 consume at least 20% more water
- 5 consume min. 20% more energy
- Worst performing unit consumes above 50% more energy and 40% more water

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Domestic HPC – failure of critical parts

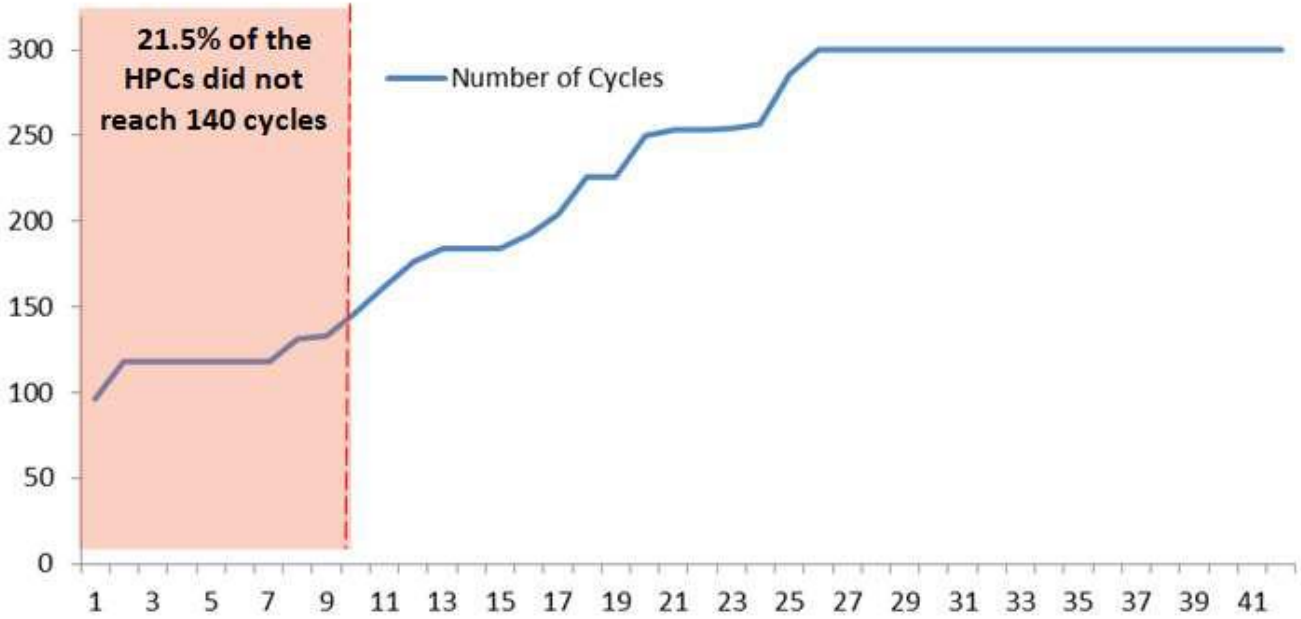
Endurance tests by stakeholders → the failures are mostly in the following parts:

- *Carbon brushes* in the electric motor are worn and no longer make contact resulting in a defective motor
- *Bearings of the motor* get defective
- *Bearings of the pump* get defective
- *Water leakages*

Consumer surveys carried out by Which? → common problems were:

- *Water leaks* from the HPC body 30%
- *Lance failed* 17%
- *Loses pressure* 15%

Domestic HPC – durability tests



42 domestic HPC - 300 *cycles - 40 minutes of duration:
15 minutes with highest pressure and maximum water Flow
3 minutes with closed nozzle jet and the machine on
12 minutes with highest pressure and maximum water flow
10 minutes pause.

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Improvement options

Energy efficiency in pumps and motors

- Motor-pump automatic shut-down (standard)
- Hydrostatic drives (BAT)
- Energy efficient water pumps (BAT)
- High efficiency motors (BNAT)
- Electric motor with variable speed drive (BNAT)
- Technologies for combustion engine powered HPCs (BNAT)
  - *(High Efficiency Hybrid Cycle (HEHC) Rotary engine)*

Energy efficiency in water heating

- High efficiency burner boilers (standard)
- Direct hot water feed (standard)
- Improved heat exchanger (BAT)
- Improved thermal insulation of heated parts (BAT)
- Use of waste heat from motor (BAT)

Improvement options

Spraying technology

- Improved nozzle designs (standard / BAT)

Water and consumables efficiency

- Use of alternative water resources (standard)
- Water recycling for stationary HPCs (standard / BAT)
- Use of water saving attachments (BAT)
- Precise detergent regulation (BAT)

Sensors and automatic controls

- Advanced control (BAT)

Design for disassembly/repair

- Use of standardised tools / Repair manual
- Spare part availability

Improvement options

Design improvements for resource efficiency (standard / BAT)

- Use of materials for longer lifetime of components (e.g. ceramic and stainless steel components for increased resistance to wear, weather, corrosion, soap, acids, chlorine etc.) /use of recycled plastic
- Improved water seals
- Design of components to reduce build-up of limescale

Design for disassembly-repair / recycling

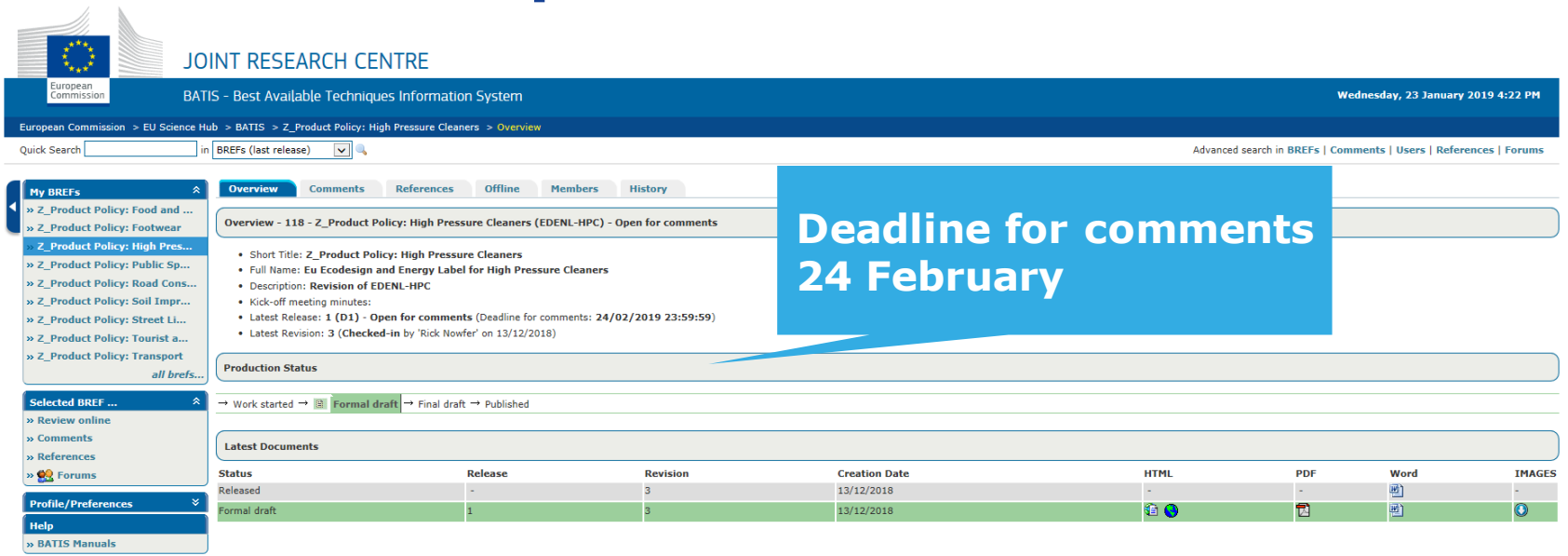
- Use of standardised tools / Repair manual
- Critical components identification → easy repair or replacement
- Modular build up → easy access to critical components for repair & recycling
- Spare parts availability

Questions and discussion

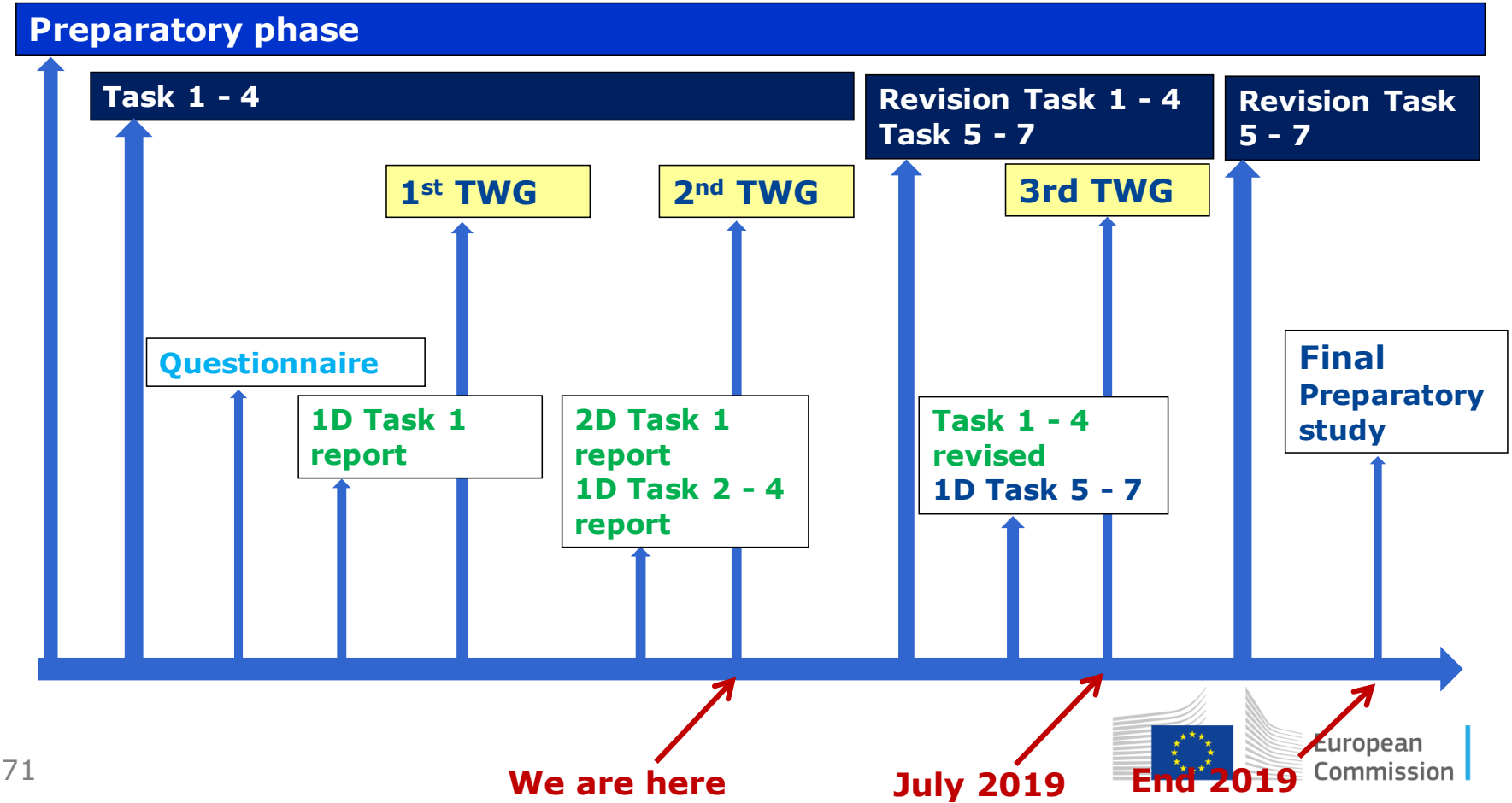
- Could you provide us BAT & BNAT improvement along with estimations of the improvement potentials in terms of energy, water, consumables savings / lifetime extension / reparability improvements
- How would reparability improvements may affect the domestic HPC market ?
- What is your opinion on setting minimum durability criteria?
- Any other comments are very welcome!

Next steps

Using the BATIS system
Please use it to provide comments!



Next steps



Thank you!