A4L_ACTIONS

Alliance for Life Sciences: From Strategies to Actions in Central and Eastern Europe

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D1.7 GREEN LABS BEST PRACTICE

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INTRODUCTION

Civilization-driven changes have a deleterious impact on the environment and sustainability of human activities. Their consequences include global warming as a result of energy usage, changes in ecology and disease patterns, loss of irreplaceable resources, reduction of biodiversity, and increasing production of waste. Therefore, protection of the environment is the highest priority for all organizations and individuals. Research laboratories in life sciences area are significant contributors to environmental burden through production of large quantities of waste (including infectious, GMO, toxic and plastic waste), consumption of large amounts of water, and consumption of large amount of energy resulting in generating CO_2 emissions. Even though the use of energy-intensive equipment, water-intensive procedures, single-use plastics, GMO and toxic reagents is important for current life sciences' research, there are meaningful ways to reduce their environmental impact.

Many high-profile universities and research institutions all over the world have introduced various "green lab" initiatives and implement specific sustainability programs in order to improve their eco-efficiency and secure their research activities and progressive development. Based on the available experiences, even modest conservation efforts can lead to significant environmental and cost benefits.

The A4L_ACTIONS partners perceive the challenges associated with lowering environmental impact of research activities and consider "green lab" approaches for important aspects of research ethics. In order to raise environmental awareness, and gain initial insight into the environmental policies and practices of A4L_ACTIONS institutions, we performed a survey addressing basic principles of an environmentally-friendly behavior. Results of the survey are intended to be used to identify good practices as well as practices that need improvements, and propose trainings and strategies to implement necessary changes in a manner specific for individual A4L_ACTIONS partners. The implementation of the changes will be assessed by the end of the A4L_ACTIONS project by completion of the same survey and comparison of the results.

SUMMARY OF THE SURVEY RESULTS

The survey consisted of six sections addressing basic topics of environmental policy and/or practice and one free text option:

1. General aspects of environmental policy
2. Purchase and sharing equipment and consumables
3. Recycling
4. Energy and water
5. Chemical management
6. Laboratory waste

Each section contained 6-14 questions related to the respective topic (see the template in the Attachment). Responses to particular questions were provided in binary form (response yes = 1, response no = 0) in order to allow for calculation of % positive (and partially positive) responses for each category of questions and for rating of overall status of this topic.

The following A4L_ACTIONS partners participated in the survey: MU CEITEC, BMC SAS, MUL, UZSM, UT, VU, LIOS, UL, MUS and UMFCD. The survey results have been anonymized.

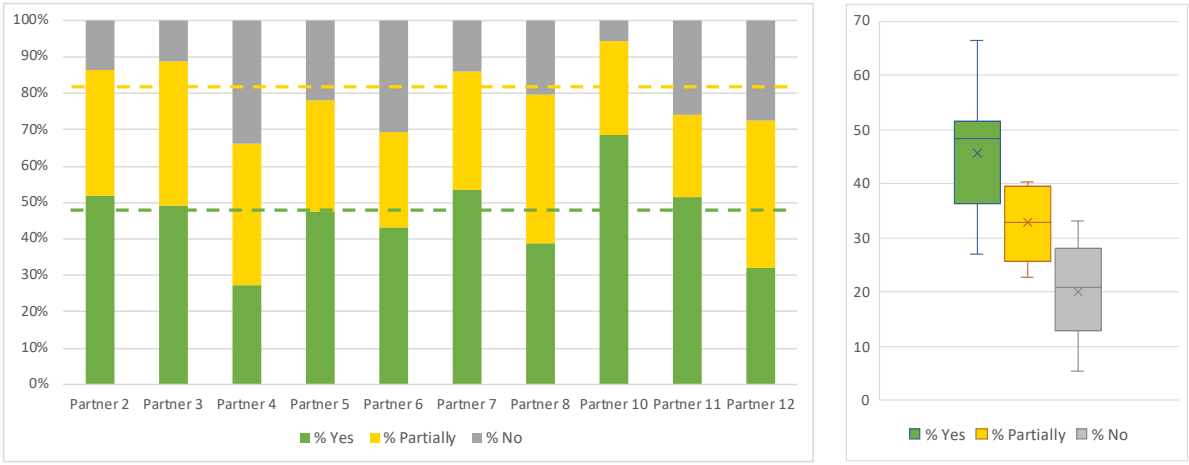

Figure 1.
Overall percentage of responses (Yes, Partially, No) to all questions in the survey, given by each of A4L_ACTIONS partners (left, column graph), or together by all partners (right, box plot with interquartile range and indicated median — and average x). Horizontal dashed lines in the left graph indicate median values for the response "Yes" (green) and "Partially" (yellow).

The graphs on Figure 1 show that the partners have variable proportions of responses indicating fully or partially implemented rules and practices of environmental policies and that there is a considerable space for improvements. Median value of "Yes" responses corresponds to 48.4 % and average to 45.7 %, median of "Partially" is 32.8 % and average is 32.8 %, median of "No" is 20.9 % and average is 20.21 %. The "No" responses include also occasional cases of "Not applicable" responses.

Management of laboratory waste is the topic that is covered by national legal regulations and implemented in practice in all A4L_ACTIONS partners' institutions (average of 91.11 % of "Yes" responses, see column and radar graphs on Figure 2 and 3). Additional topics that appear to be relatively well addressed include energy and water, recycling and chemical management (average of 49.13 %, 48.75 % and 38.75 % of "Yes" responses) at least partially because their management is subject to strict regulatory rules. The topics that would require more attention include purchase and sharing of equipment and consumables (average of 25 % of "Yes" responses) and general aspects of environmental policy, which cover guidelines, training etc. (average of 21.25% of "Yes" responses). These latter topics represent potential targets of future activities towards implementation of environmental policy in practice. More detailed information on the particular questions that were responded by the A4L_ACTIONS partners within the topics is provided below.

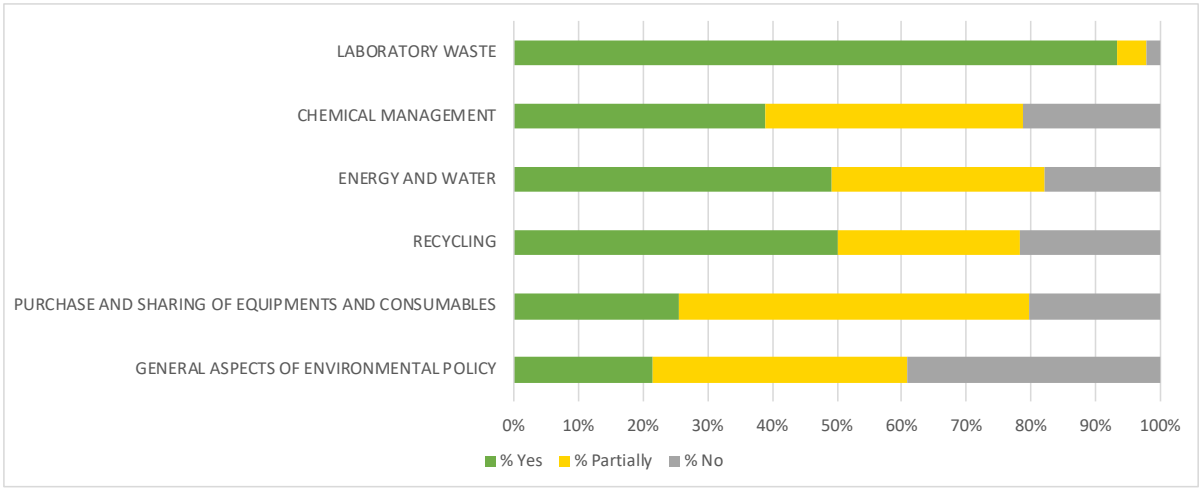

Figure 2.
Average percentage of responses (Yes, Partially, No) to questions included in the survey topics by all partners.

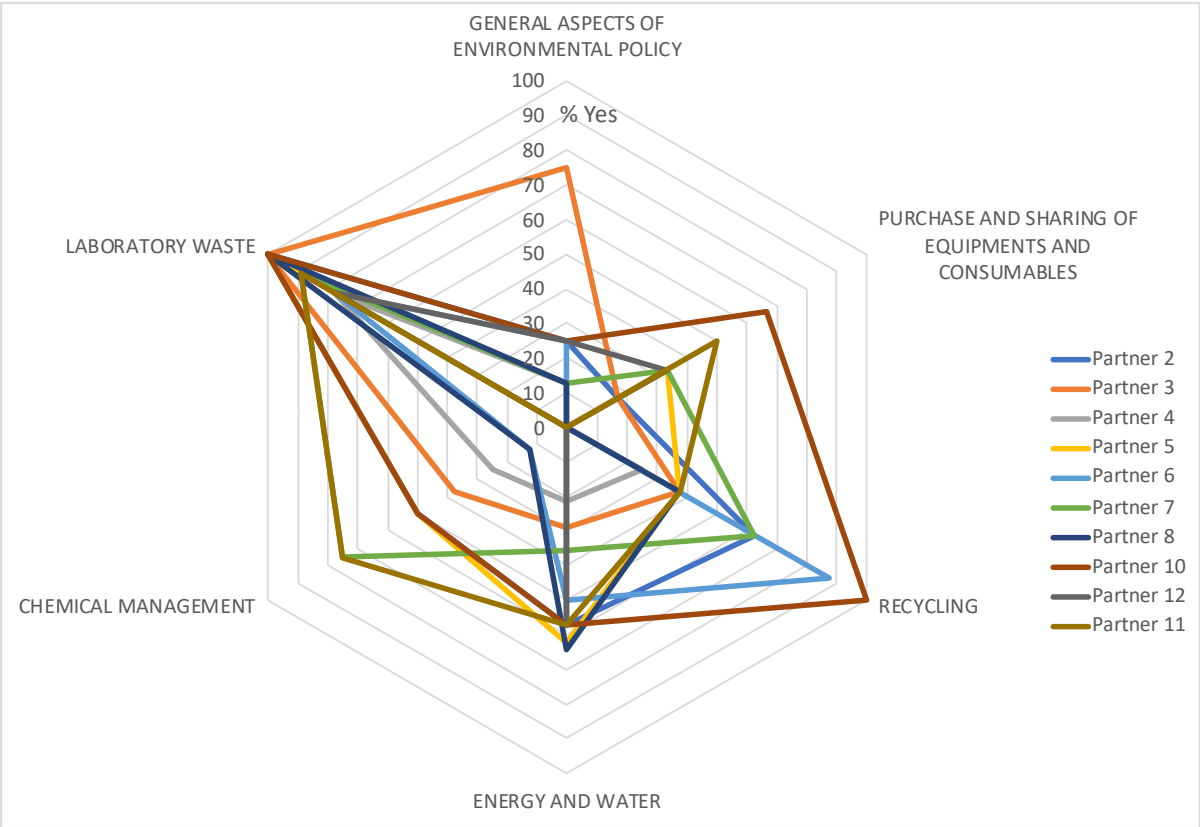

Figure 3.
Radar graph illustrating average percentage of "Yes" responses by each A4L_ACTIONS partner participating in the survey to the topics of environmental policy. Individual partners are discriminated by colors as depicted in the legend.

Graphical illustration of average "Yes" responses by institutions participating in the survey (Figure 3) exhibits similarities as well as differences among the A4L_ACTIONS partners in implementation of the diverse aspects of the environmental policy. It is clearly visible that all institutions focus mainly on management of laboratory waste, paying variable attention to other aspects. Both Figure 1, left graph, and Figure 3 show that Partners 10, 2, 3 and 7 are experienced in several topics and can provide some examples of a good practice. However, even they still need further improvements.

In order to understand, where are the specific opportunities for advancement, each topic was analyzed separately, as described further below.

1. GENERAL ASPECTS OF ENVIRONMENTAL POLICY

The environmental policy including the Green lab concept can have various formats depending on the type of the research institution and/or characteristics of the research area. There are different rules for molecular biology laboratories (GMO), chemical laboratories (toxic substances), virological laboratories (infectious agents), diagnostic laboratories, and these specific features have to be reflected in the practical life. Life scientists often have to maintain strict conditions of sterility, safety and keep rigorous protocols , and thus do not have unlimited opportunities for reduced use of reagents and energy/water savings. Therefore, researchers have to find a balance between ecologically friendly behavior and requirements for correct research procedures.

This topic of the survey monitors whether A4L_ACTIONS partners are aware of Green lab strategy concept and EU environmental policy, whether there are related guidelines, trainings, dedicated personnel at their institutions and whether carbon footprints are annually calculated and recorded.

Table 1.
Overview of the feedback of A4L_ACTIONS partners to questions related to general aspects of environmental policy. Reponses "Yes" are indicated by green color and are assigned value 1, responses "Partially" are indicated by light orange and are assigned value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

GENERAL ASPECTS OF ENVIRONMENTAL POLICY	2	3	4	5	6	7	8	10	11	12	SCORE
Is your institution aware of Green Lab strategy and EU Environment Policy?											8
Is your institution planning Green Lab strategy?											6,5
Is your institution implementing Green Lab strategy?											2,5
Is there a guideline on environmental policy/Green Lab strategy at your institution?											3,5
Is environmental training provided during new staff introduction?											4,5
Are annual update sessions on environmental management run?											2,5
Is there a personnel dedicated to environmental management / monitoring?											4
Is carbon footprint of your institution annually calculated and recorded?											1

Overall, there were only 17 positive responses and 30 responses "partially" out of 80 possible reactions (10 partners, each 8 responses) to questions in this topic. Six out of ten A4L_ACTIONS partners are fully aware of Green lab strategy concept and EU Environment Policy (Score 8), four responding institutions are planning the Green lab strategy, but none of them is currently fully accomplishing its implementation. Only two responding institutions possess guidelines on environmental policy/Green lab strategy, or provide the environmental training during the new staff introduction, or have got personnel fully dedicated to the environmental management/monitoring. Only the Partner 3 runs annual update sessions on environmental management. None of the partners performs annual calculation and recording of carbon footprint, but several partners claimed the follow-up of energy intensity in their free text notices.

The partner 3 appears to be the most advanced institution in this topic, with experiences that can serve as a good practice for the other A4L_ACTIONS partners (see the section 7 of this deliverable).

2. PURCHASE AND SHARING OF EQUIPMENT AND CONSUMABLES

Informed purchasing decisions for replacement of outdated and energy-intensive equipment by more sustainable, energy-efficient products is one of the approaches to support the sustainability goals and conserve energy and water consumption. Sharing of equipment is another way of reducing costs from

duplicate purchase and energy /water consumption. This applies not only to specific instruments, but also to ice machines and distillation set-ups.

Similarly, plastic sustainability can be supported by the decisions about what to buy. This requires spending some time by doing research how the suppliers produce the plastic and which plastic can be reused or recycled (polypropylene or high-density polyethylene materials are widely used for lab equipment and are recyclable). This approach can also include communication with the supplier whether it is possible to cut down on unnecessary plastic packaging for the products delivery and whether the supplier has recycling program that can be used when disposing the plastic (upon preserving all requirements of safety). Sharing of toxic or carcinogenic reagents to avoid their duplicate purchase, especially in cases of short expiration terms, can also contribute to reduced environmental burden.

Survey questions in this topic cover purchase of equipment with respect to sharing, reducing packaging waste and recycling (Table 1). Only three A4L_ACTIONS partners fully share the equipment among their research groups or departments, but all the remaining partners do that partially. Similarly, equipment purchase is fully based on the requirement for most frequent use by two A4L_ACTIONS institutions, while the other institutions consider this aspect partially. Consideration of environmental benefits is not a prevailing practice as only six partners claimed its partial application when making purchases. Consolidated purchases with reduced packaging waste are carried out by the five A4L_ACTIONS partners, additional three do it partially. Finally, purchase of recyclable plastics is performed partially by five partners. Thus, these approaches should be better introduced in the practice. The best practice in this topic was reported by the partner 10.

Table 2.
Overview of the feedback of A4L_ACTIONS partners to questions related to purchase and sharing of equipment and consumables. Reponses "Yes" are indicated by green color and are assigned the value 1, responses "Partially" are indicated by light orange and are assigned the value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

PURCHASE AND SHARING OF EQUIPMENTS AND CONSUMABLES	2	3	4	5	6	7	8	10	11	12	SCORE
Is equipment shared among research groups / departments?											6,5
Is equipment purchased based on requirements for most frequent use?											6
Are environmental benefits considered when making purchases? (e.g. energy star ratings, off switches, recirculated cooking water)											3
Is reusable equipment purchased where possible?											6,5
Do you consolidate purchases to reduce packaging waste?											6,5
Do you consolidate purchases in favor of recyclable plastic and/or plastic composed of recycled or compostable material?											2,5

3. RECYCLING

Scientific research significantly contributes to plastic waste. Globally, it is estimated to produce five and a half million tonnes of plastic. Research in life sciences alone is thought to be responsible for 1.8 per cent of total global plastic production (https://www.nature.com/articles/528479c.pdf, https://www.sciencedaily.com/releases/2015/12/151223221353.htm).

Plastic has a number of properties that make it useful in the lab like being shatterproof, durable and lightweight. Widely used lab equipment such as multi-well plates, pipettes, bottles, flasks, vials and culture plates are all commonly made of plastic. On the other hand, plastic is extremely durable and can take hundreds of years to degrade. In addition, production of plastic is not ecological. Thus, it is important to reduce the negative impact of plastic on the environment. It is possible to achieve it at least partially via using glass pipettes, cultivation flasks or dishes, which are, however, more water-

intensive. Some types of plastic can be autoclaved and reused (if the plastic items were not used for biohazardous or radioactive reagents.

There are also other items used by the researchers as well as by the administrative staff, such as printer cartridges, mobile phones, batteries, old computers etc., which can be subject to reuse and/or recycling.

The survey included questions related to recycling of different items. This topic is quite well covered by "Yes" responses, indicating that the A4L_ACTIONS partners are aware of its benefit. The best feedbacks were provided on collection of wasted paper and recycling cartridges (8 "Yes" each, score 8.5 and 9), then on recycling batteries (6 "Yes", score 7) and computers (5 "Yes", score 6.5). Recycling of packaging material, mobile phones and obsolete lab equipment received just 3 "Yes" responses each. The best practice in this topic was reported by the partner 10, which positively responded to all questions.

Table 3.
Overview of the feedback of A4L_ACTIONS partners to questions related to recycling. Reponses "Yes" are indicated by green color and are assigned value 1, responses "Partially" are indicated by light orange and are assigned value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

RECYCLING	2	3	4	5	6	7	8	10	11	12	SCORE
Is all waste paper in collected in paper bins and recycled?											8,5
Is packaging material recycled?											6
Is polystyrene recycled?											4
Are empty printer cartridges recycled?											9
Are mobile phones recycled?											3,5
Are batteries recycled? Is there a designated collection spot and do researchers know about it?											7
Is obsolete computer equipment recycled?											6,5
Is obsolete lab equipment recycled? (e.g. exchange, sale or auction)											5,5

4. ENERGY AND WATER

Research laboratories are highly energy intensive. The typical laboratory uses 3 to 6 times more energy per unit surface area than the typical office building. The high-energy consumption maybe attributable to the density of high usage equipment; the hours of operation and the need for temperature as well as humidity control. A significant amount of energy consumption is due to ventilation. Lighting can account for around 15 percent of the energy and equipment accounts for another 20 percent of the energy use in the lab.

A simple way to save energy is to turn off the lights when the lab is unoccupied or when there is enough daylight, and to identify equipment that can be turned off when not in use. This applies mainly to tissue culture hoods, which are the most energy-intensive equipment in the labs. Freezers are another big focus for energy conservation that are unique to research labs. Changing the freezer temperature set point from –80°C to –70°C, could save marked energy costs. Autoclaves are also highly energy intensive and therefore should only run when full.

Besides energy, research laboratories are also high consumers of water. Reduction of excessive consumption of water can lead to both real cost savings and an improved environmental footprint.

However, significant reduction of energy and water consumption cannot be achieved just by individual control over running time and intensity of use of all electric equipment, but often requires initial

investments into new, energy-efficient devices, lights, freezers etc. This may pose an obstacle to implementation of Green lab strategy, which has to be overcome to achieve the desired eco-friendly changes.

This survey topic contained 14 questions related to rational use of electric devices and water-saving practices. The best scores were obtained for operation of tissue culture hoods, sharing distilled and purified water and ice, switching off hard drivers and air-conditioning. In contrast, only two partners have in place the water-saving programs and other two partners possess established rules for efficient labware washing practices. The most positive responses to questions in this topic were given by the partner 5.

Table 4.
Overview of the feedback of A4L_ACTIONS partners to questions related to energy and water consumption. Reponses "Yes" are indicated by green color and are assigned value 1, responses "Partially" are indicated by light orange and are assigned value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

ENERGY AND WATER	2	3	4	5	6	7	8	10	11	12	SCORE
Have all incandescent lights been replaced with more efficient lighting?											7
Has a lighting audit been undertaken?											6,5
Are light switches programmed to turn off in empty areas?											4,5
Are hard drives and monitors (computers) switched off or on power save?											7,5
Are printers and photocopiers switched off when not in use?											6,5
Is the air conditioning switched off or on a sensor/timer?											7,5
Are fridges and freezers regularly cleaned out and consolidated?											7
Are there inventories of valuable frozen samples?											7
Are appliances run only when they have a full load? (e.g. autoclaves, glasswashers)											7
Are tissue culture hoods turned off completely when not in use? (with max 30 min UV sterilization if necessary)											9
Do you have water-saving program?											2,5
Do you established rules for efficient labware washing practices?											3,5
Do you share ice makers among research groups / departments?											8
Do you share systems for distilled and purified water among research groups / departments?											8,5

5. CHEMICAL MANAGEMENT

Management of chemicals in research laboratories in life sciences includes acquisition; inventory and tracking; storage in stockrooms and laboratories; recycling and/or disposal of chemicals and laboratory materials, and reducing and eliminating the use of hazardous substances (green chemistry) where applicable. All these elements are subject of strict regulations by numerous legal acts.

To promote a responsible use of chemicals, the research institution should have an inventory of chemicals stored and used, with clear identification of the name of the chemical, hazard class, container locations and dates on use and expiration. In addition, there is a need to possess guidelines specifying how hazardous waste from research chemicals has to be stored, treated, and disposed. Finally, chemical management should be regularly monitored and updated, optimally by dedicated Health, Safety and/or Environment staff, in line with existing standards of regulations and permits by legal authorities.

This topic monitors how A4L_ACTIONS partner institutions deal with chemical management, whether there are guidelines, chemical tracking systems, chemicals' sharing and whether green chemistry equivalents are used.

Most of the partners reported guidelines of disposal chemical waste and declared that chemicals are ordered based only when needed. Only two responding institutions share chemicals between departments, the other six institutions do it partially. Tracking systems are not fully implemented in any of the A4L_ACTIONS partners, while its partial use was claimed by seven survey participants. The best performers in this topic are partners 7 and 11.

Table 5.
Overview of the feedback of A4L_ACTIONS partners to questions related to chemical management. Reponses "Yes" are indicated by green color and are assigned value 1, responses "Partially" are indicated by light orange and are assigned value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

CHEMICAL MANAGEMENT	2	3	4	5	6	7	8	10	11	12	SCORE
Is there a guideline how to determine if a chemical can go down a sink?											6,5
Is there a guideline for the process of solid waste disposal?											8
Is there a guideline for chemical waste collection?											7,5
Are chemicals/reagents only ordered on an as needs basis?											7,5
Are chemicals/reagents shared with other research groups within departments?											5,5
Are chemicals/reagents shared with other departments?											5
Are Green Chemistry alternatives investigated when setting up experiments / projects?											3
Is a chemical tracking system used for the labs?											3,5

6. LABORATORY WASTE

One of the most noticeable environmental impacts in the lab is the amount of waste. The best solution is to avoid waste from the start, and there are many ways to address this task. While legal regulations on good practice exist in many countries, especially in regard to waste management, there is a need for laboratories to go beyond existing legislation and take positive steps to identify and reduce their environmental impact.

Responses to the questions in this topic clearly show that all partners are fully or almost fully practicing management of laboratory waste. Few responses indicated by grey color represent here "not applicable" response by the partners not working with cytotoxic, infectious, GMO and radioactive reagents. Thus, this topic does not need too much improvement and is rather the subject of sustainability.

Table 6.
Overview of the feedback of A4L_ACTIONS partners to questions related to laboratory waste. Reponses "Yes" are indicated by green color and are assigned value 1, responses "Partially" are indicated by light orange and are assigned value 0.5. Final score of the feedback to individual questions corresponds to sum of values of all responses.

LABORATORY WASTE	2	3	4	5	6	7	8	10	11	12	SCORE
Is animal waste disposed of correctly?											10
Is animal waste stored of correctly?											10
Is cell culture waste disposed of correctly?											10
Is there a guideline and special bins for biological non-infectious waste disposal?											9,5
Is there a guideline and special bins for biological cytotoxic waste disposal?											9
Is there a guideline and special bins for biological infectious waste disposal?											9
Is there a guideline for biological GMO waste disposal?											8,5
Are there persons taking care for emptying bins with laboratory waste?											9,5
Is there a guideline for radioactive waste disposal?											8,5

TOWARDS A GOOD PRACTICE

Development and implementation of an environmental policy is a key prerequisite of sustainable research that will be accessible and attractive for future generations of scientists. The final goal of this policy is to minimize the negative impact of current research on our planet. Achievement of this goal and successful introduction of good environmental policy into practice depends on commitment of both laboratory and administration staff and on the support of senior management, especially when starting investment is necessary. Finally, it is also important to address suppliers and other stakeholders to mirror the institution's commitment to environmental responsibility. This participative approach allows for proposal of the Green lab strategy, including specification of environmental targets and objectives and definition of concrete steps towards sustainable improvements.

There are numerous examples of good practices of green lab strategies implemented at high-profile universities and research institutes worldwide, with more or less detailed guidelines and instructions that can be adapted to the needs of other institutions (see the references below). In addition, many grant agencies consider environmental policy as an important characteristic of responsible research and require statement of its implementation within the project proposals.

The A4L_ACTIONS partners understand the importance and added value of the full implementation of the environmental policy principles into their research practice. Each partner has already introduced some rules of environment-friendly behavior and considers and/or is planning the Green lab strategy. Indeed, the partner 2 has recently engaged professional experts to propose tailored strategic procedures and facilitate their implementation in daily life.

The A4L_ACTIONS partner 3 is the most advanced institution in this area, with experiences that can serve as a good practice example to the other A4L_ACTIONS partners. It has established an environmental policy program based on sustainable management of construction investments and promoting pro-ecological behavior. The program supported by national and provincial funds of environmental protection includes thermal modernization of buildings, replacement of heating, ventilation and lightning systems, waste management with bins for separation, installation of access control systems and energy management in the buildings, installation of photovoltaic, construction of energy-saving and passive buildings.

In addition, the program targets access to public transport and creation of city bike parking lots, introduction of water-saving system, replacement of single-use plastic bottles to reusable bottles, installation of drinking water dispensers.

The process of implementation is supported by establishing a platform for administrative processes and reducing the flow of paper correspondence as well as by centralized printing of paper documentation on plain or ecological paper. This is supplemented by pro-ecological education information stickers, motivation through contests, regular meetings of dedicated personnel, organization of events, changes in catering contracts (less calories, no plastic, more fruit), introduction of e-learning, gain of experiences through study visits in green campuses of top universities, organizing environmental conferences and summer schools, cooperation with other entities etc.

Based on these activities, the partner 3 received a national award for a conscious approach to the implementation of the pro-ecological policy, including the development of the campus concept with energy-efficient solutions.

CONCLUSION

The present survey has demonstrated that A4L_ACTIONS partners are aware of the environmental policy value and are already in the process of its partial implementation. Furthermore, the survey has identified aspects of the green lab concept that are insufficiently addressed and showed that there are opportunities for improvements through education, transfer of knowledge and activities leading to its practical applications. The A4L_ACTIONS project will provide support to these activities.

LITERATURE:

https://www.europarl.europa.eu/factsheets/en/sheet/71/environment-policy-general-principles-and-basic-framework
https://www.labmanager.com/business-management/making-sustainable-labs-a-reality-22090
https://www.promegaconnections.com/making-research-more-sustainable-one-lab-at-a-time/
https://www.greenbiz.com/sites/default/files/document/CustomO16C45F38100.pdf
https://www.labmanager.com/business-management/lab-manager-guide-to-sustainable-lab-practices-3159
https://green.harvard.edu/tools-resources/how/beginners-guide-starting-green-labs-program
https://green.harvard.edu/sites/green.harvard.edu/files/tool-resource/field_file/harvard_university_lab_sustainability_guide_april_2013.pdf
https://www.radleys.com/blog/how-to-use-plastic-more-sustainably-in-the-lab/
https://www.i2sl.org/documents/toolkit/bp_opt_vent_508.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5548370/
https://www.nature.com/articles/528479c
https://green.harvard.edu/sites/green.harvard.edu/files/GreenLabsGuide.pdf
https://blogs.ed.ac.uk/sustainability/2019/university-laboratories-plastic/
https://www.environment.admin.cam.ac.uk/files/environmental_sustainability_vision_policy_and_strategy_for_web.pdf
https://nems.nih.gov/Documents/Self-Assessment%20Green%20Labs%20Program%2010292019_Final.pdf