HOW TO IMPROVE THE RESEARCH CULTURAL ENVIRONMENT

A literature Review

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with contributions by
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GENERA publication, Grant Agreement Nr. 665637
http://genera-project.com

Introduction and Aims

This report documents the findings obtained through a comprehensive literature review, analysis of available data on partner institutions (results from the GENERA 2.1. task) , as well as a widely-scoped cross-sectional selection of Gender Equality Plans (GEPs) implemented across countries and institutions partaking in the GENERA Consortium and beyond. It constitutes the Deliverable 2.2. of the GENERA project.

The goal of Task 2.2., carried out under the GENERA's Work Package 2 *Status of research intensity advancing GEP activities in Europe's RPOs and RFOs* and led by the Jagiellonian University's team of GENERA researchers, is to **map and identify successful gender equality measures and conditions for improving research cultural environment in the fields linked to physics**. Special emphasis in the task is on pinpointing the "best practices" and "best in class" examples of innovative approaches. This is further achieved by a multi-focus approach. First, the research presented in this Report investigates what are the gaps in the current GEPs that are often too generic to capture the specific disciplinary challenges and needs – as in the case of Physics. An in-depth look at GEPs is seen as conducive to completing the goal of highlighting the necessity of transnational approaches to projects that compare research infrastructures and data cross-nationally. Discussions of cultural aspects – i.e. mobility constrains, local scientific cultures, funding bodies – in the current GEPs can further foster formulation of features for new, revised and customized GEPs. Secondly, it attempts to advance the knowledge on particular barriers that make research environments in physics suboptimal for female researchers. Thirdly, the study aims at analysing the emerging subfields of Physics as a broad discipline, seeking to determine whether links to other sciences, interdisciplinary character and novelty of the subfield's instating process have any impact on gender indicators and results of GEPs. In addition, the goal of the last subtask is to discuss the type of the impact per each examined new field of physics.

Approach and Methods

This literature review has been based on a wide-scoping of various secondary sources of academic research, as well as key findings of recent projects found in international reports, advisory briefs and similar material.

The selection of literature relied on both the commentary on broad structural dimension, and the more pragmatic approach or unveiling specific examples of good practices, solutions, and their assessment obtained through scholarly research. A good practice is here understood as "any experience or initiative with techniques, methods or approaches that produce effects and results coherent with the definition of gender mainstreaming. They are considered to be effective in delivering gender mainstreaming as a transformative strategy, and therefore deserving to be disseminated and proposed to other organizational contexts" (EIGE Concepts and Definitions).

The GENERA "Fields of Action" have guided the literature review and are mirrored across the sections of this document. As certain themes, however, collided on a search and results levels, they have been combined for the purpose of this Report. As such, thematic and categorical analyses permeated investigations in the five broad subsections.

Depending on the relevance, breadth and dearth of research in each given subtheme ("Field of Action"), the literature searches generally reflected a five-level procedure, moving in from the broad bird's-eye view of a theme, to zooming in on the specificity of physics or emergent physics' subfield. In a middle-step, studies pertinent to all gender in STEM and academia was used. From the broad collection and selection of sources, best practices for promoting gender equality in physics were inferred.

Findings

Gender inequality and gender discrimination is encountered in all areas of social life, including labour market and employment. Within labour market, sex disproportions in science – and specifically in STEM disciplines[1] – are pervasive. The case of physics is indicative, as there is a significant under-representation of female scientists at universities and research institutions in this field (Elsevier 2017). Additionally, female physicists, in comparison to their male peers, seldom reach top positions but often leave the academic research environment. It is true in case of Europe, where "women do not move up through the echelons of scientific careers in the same way as their male peers and the gender imbalance exists, in varying degrees" (Hasse, Trentemøller 2008: 189). At the same time, however, it has been noticed that the representation of female physicists in universities is geographically uneven, as there is a higher representation of them in the Southern Europe and Central and Eastern Europe and low representation in the North (Hasse, Trentemøller 2008: 188)[2].

The cause of the gender inequality in physics – and in science in general – is a complex issue and cannot be based on a single factor. In a growing number of analyses of impediments to female scientific career, it has been demonstrated that gender imbalance in science results from an interplay of many institutional, social, cultural and individual factors. They include – but are not limited to – gender stereotypes and implicit biases, traditional image of an ideal scientist connected with the masculine nature of science, gendered understandings about 'appropriate' and 'natural' male and female interests introduced at the early age and continuing throughout adolescence and adulthood, unfavourable academic climate for female scientists (commonly referred to as a 'chilly climate'), sex segregation of occupations, social norms of burdening women with excessive family responsibility for childcare, elderly care and household management, demands of full work-devotion within academia and STEM in particular, covert discrimination in the form of old boys' networks, biased hiring practices, unfair distribution of resources, cultural perceptions of femininity and masculinity, bullying and harassment, as well as career preferences and lifestyle choices (Rosser, Lane 2002; Callister 2006; Committee on … 2006a, 2006b; Settles, Cortina, Malley, Stewart. 2006; Hasse, Trentemøller 2008, 2011; Hill, Corbett, Rose 2010; Hirshfield 2010; Kelly 2016; Maranto, Griffin 2011; McCullough 2011; Pettersson 2011; Ryan 2012; Hughes 2014; Alegria, Branch 2015; Corbett, Hill 2015; Lucht 2016; Sax, et.al. 2016).

Similarly, the differences in the scope of gender imbalance in science throughout Europe may be attributed to various factors, including perception of education in a society, the level of the economic development of the country and the shape of the labour market, perception of class in relation to gender, the prestige of science, the impact of religion on gender role attitudes and child care policies. It has been observed that there is more women in physics education and research in these countries where same-sex secondary schools are popular, teaching physics in secondary schools is compulsory, economies are developing (and not already highly developed), science has not had a long tradition of male dominance, the importance of class overrules gender, the level of prestige of science is lower and Catholicism predominates over Protestantism (cit. after Hasse, Trentemøller 2008: 13-18). However the impact of these characteristics is not unexceptional, it does not explain all the differences between the European countries in the scope of gender inequality in physics. It is therefore argued, that –

[1] STEM stands for science, technology, engineering and math.
[2] However, it is argued that this stronghold of women in physics in the eastern European countries might gradually lessen, as "the period of transition from the old, centralist system to the modern, market driven economies seems to have affected female scientists' careers negatively" (Hasse, Trentemøller 2008: 189).

apart from the above mentioned mechanisms that operate outside physics – it is necessary to analyse the impact of the cultural patterns within the activity of physics (within organisations), which "function as different frames within which the inclusion and exclusion of scientists take place" (Hasse, Trentemøller 2008: 22).

The following literature review traces the relevant areas of gender equality in science and tie them to the existing GENERA's Fields of Action framework. Therefore, it identifies the existing research findings across six broad areas of gender-relevant issues, examining them in the world of physics and beyond. These areas include: 1. Structural Integration and Policy, 2. Engaging Leadership, 3. Flexibility, Time and Work Life, 4. Presence and Visibility, 5. Gender-inclusive / Gender-sensitive Organizational Culture, and 6. Gender Dimension in Research and Education. When considerable overlap occurs, some dimensions are linked together in the analyses.

Chapter I Structural Integration of Gender Equality

This section covers the literature concerned with how to design, implement and pursue successful policies aiming at achieving gender equality in science. The works reviewed in this section in particular discuss the issues of well-design policies, factors that enhance of hinder conducting effective monitoring of gender equality and making gender equality sustainable as well as the problems of gender-balanced composition of decision-making bodies and the powers of gender equality offices.

1. General conditions for effective gender equality policies

Within the GENERA Fields of Action policies refer to all programmes, strategies, courses or principles of action and objectives that aim at achieving transformative change towards gender equality directly and indirectly.

International organizations have widely tackled the problem of gender inequality in labour market, including the area of science and research. Ensuring women's equal access to science and technology became one of the strategic objectives (B.3) set by the UN in the Beijing Declaration and Platform of Action. The UN established the Gender Advisory Board in 1995 to provide advice to the United Nations Commission on Science and Technology for Development (UNCSTD). It monitors the implementation of the recommendations made by the Commission on gender and science and technology, and provides assistance in their implementation. Moreover it advises the Commission on the gender implications of its new work programmes (About the GAB n.d.).

As far as the European context is concerned, the idea of equal pay for equal work was one of the first areas of gender equality to be referred to in the EU's policies (Article 141 of the Treaty of Rome 1957). The first step towards European gender equality policy in the field of science was the European Commission communication entitled **"Women and science" – Mobilising women to enrich European research**", in which significant efforts to increase women's participation in the EU research programmes and establishment of a working group on "Women and science" were announced (European Commission 1999). It was immediately followed by the Resolution on Women and Science, in which the Council of European Union (1999) invited both member states and the Commission to contribute to the assessments of the situation of women in research area and on-going policies as well as to the development of further initiatives to promote women in science (European Commission 2001; Jurviste, Stull 2015)[3]. While since then some progress has been made in the member states, women remain under-represented in the EU research and science (Jurviste, Stull 2015; She Figures 2015).

Accordingly, the EU (as well as the UN and other international organizations) may be seen as a self-defined gender equality norm-setter and policy-inspirer/initiator and its impact on gender equality policies and practices in its member states can be analysed. At the same time it is necessary to acknowledge that gender equality and gender equality policies are geographically contextualized, which means that they are affected by different cultural and political traditions and current patterns of separate countries and/or regions. In fact there are

[3] For the further developments in the EU's undertakings in the field of gender equality in research see for example Forest, Arnaut, Mergaert 2016.

substantial differences within the group of European societies in understanding gender, diagnosing and prognosticating of the problem of gender inequality, the degree of politicizing gender inequality, targeting certain groups with actions, locating the problem of gender inequality and defining solutions to it (comp. Verloo, Lombardo 2007). Similarly, there are varied and complex differences throughout Europe in the content and quality of gender equality policies. They are argued to be linked to "to the content and nature of the civil society/state interface, political opportunities and coalitions or opponents, and to the wider environment, most importantly gender regimes but also the wider international environment" (Verloo et al. 2011: 53). Therefore there are various patterns of Europeanisation[4] of gender equality, or various patterns of domestic adaptations to the EU's gender equality policies rather "than simple reactions to 'Brussels'" (Radaelli 2004: 4).

Conducive national legislative and policy backgrounds have been recognized to be important facilitators of institutional change for gender equality in RPOs and RFOs in Europe. Together with international standards and polices they can produce powerful incentives for introducing GEPs[5] (Linková et.al. 2007; Lipinsky 2014; Vinogradova, Jänchen, Obexer-Ruff 2015, Zippel, Ferree, Zimmermann, 2016). However, European countries differ significantly in legislation and policies for integrating gender equality in research institutions, similarly as in general gender equality legislation and policies (Forest, Arnaut, Mergaert 2016). They have been divided into two broad categories: 1. "proactive countries, which promote and monitor gender equality in research and research funding with active policies and measures", and 2. "countries relatively inactive in this area, with few, if any, initiatives" (EC 2009: 5).

Within the category of proactive countries three distinct subgroups were identified. The first subgroup consists of Finland, Norway and Sweden which have been particularly active in promoting gender equality in research and research funding since the late 1970s - early 1980s, as well as Denmark and Iceland. The second proactive subgroup includes Austria, Germany, Switzerland, Netherlands and Belgian Flanders. They have more recently introduced advanced gender equality policies and measures. At the same time they encounter the largest under-representation of women in research in Europe. The third group of proactive countries combine innovative measures adopted more recently than the Nordic countries with larger proportions of female researchers than in the previous group. These characteristics refer to the United Kingdom, Ireland and Spain. The rest of European countries – including 17 Member States and two associated countries (BG, CY, CZ, EE, FR, GR, HR, HU, IL, IT, LT, LU, LV, MT, PL, PT, SI, SK, TR) were identified in 2009 as 'relatively inactive' with little reaction to policy impulses relating to gender equality (EC 2009). This classification seems to hold currently true, however France has improved its position from relatively inactive to proactive (Lipinsky 2014: 13), namely to the subgroup of countries that have recently introduced advanced policies and measures and, at the same time, have relatively large under-representation of women in research (compare European Commission 2016). While *de jure* gender equality is granted all over Europe, the gap between proactive and inactive countries seems however to widen (Lipinsky 2014: 18).

[4] Europeanisation is here understood as consisting of "processes of a) construction, b) diffusion and c) institutionalisation of formal and informal rules, procedures, policy paradigms, styles, 'ways of doing things' and shared beliefs and norms which are first defined and consolidated in the EU policy process and then incorporated in the logic of domestic (national and subnational) discourse, political structures and public policies" (Radaelli 2004: 3; Lombardo, Forest 2011: 7)

[5] These incentives include financial awards (in Norway), medal awards (Athena Swan) and 'HR excellence in research' logo awarded by the EU (Lipinsky 2014: 20)

Austria, Spain, Germany, Norway, Italy, Finland and France have legal provisions in place that obligate universities and/or other public research institutions to explicitly create equality plans. In addition, in Denmark, Sweden, Hungary and Iceland, laws require workplaces over a certain size to draw up gender action plans. In seven other countries (Belgian Flanders, Switzerland, Croatia, Estonia, Romania, Turkey, United Kingdom) a legal basis or other rules exist for the creation of gender equality plans; however equality plans are not explicit or obligatory instruments (Lipinski 2014; EIGE b; Vinogradova, Jänchen, Obexer-Ruff 2015)[6]. "In other cases, gender action plans are used without explicit requirement and other tools could be in place to encourage institutional changes." (Lipinsky 2014: 19)

As previously mentioned, practices centred on gender-equality in research organizations have been a prime concern for the institutions of the European Union and beyond (EC 2010:119). The 2014 ERA Survey of the RPOs demonstrated that, in fact, many European RPOs introduced solutions aimed at combating gender inequality in a research workshop in 2013 or prior. Among the RPOs, the main recommendations and the ensuing surveying pertained to the following measures:

- flexible career trajectory (e.g. enabling career interruptions, returning schemes after career breaks);
- 'gender-aware' working conditions;
- provisions for having dual-career family arrangements;
- gender-sensitive promotion measures;
- support for leadership development (e.g. mentoring and/of networking opportunities for female researchers)
- targets to ensure gender balance in recruitment committees
- work–life balance measures (e.g. parental leaves, flexible working arrangements) (see EC, 2010, Castano et al. 2010).

Among all mechanisms, the European RPOs across different countries have had the highest preponderance for implementing introduction of work– life balance measures, while the provisions to enable the adoption of a flexible career trajectory came second and also appear to be a relatively widespread practice to support gender equality (EC 2015:121). Importantly, in the survey there has been no definite conditionality between introducing Gender Equality Plans and deployment of gender-equality measurements in general. In other words, not all RPOs who have adopted gender equality measures have adopted a GEP, or vice versa.

Apart from existence of political will and commitment at the highest level and supportive and harmonized national legislative and policy frameworks that are in compliance with international standards and guidelines (European Commission 2003; McGregor, Bazi 2007; Verloo et al. 2011; European Commission 2012a, 2012b; Lipinsky 2014; UNDP 2014), other general recommendations for efficient gender equality policies in research and science can be formulated. Firstly, it is acknowledged that these policies should be comprehensive and tailored. This means they should relate to various aspects of gender inequality in the institutions and employ a wide range of short, medium and long-term initiatives, which will be implemented at various institutional levels and depend on national, local and institutional

[6] In Lipinsky's report Germany was classified together with seven other countries where GEPs are not explicit or obligatory instruments. However, as currently higher education acts in all German Länder obliges universities to issue gender equality plans and a provision of the Federal Equality Law obliges non-university public research institutions to issue a gender equality plan, it seems justified to place Germany among the countries where legal provisions on gender equality in research are mostly advanced (Forest, Arnaut, Mergaert 2016).

contexts (Lee, Faulkner, Alemany 2010; Lipinsky 2014; Pépin et.al. 2014). Comprehensiveness also means tackling both surface and deep levels of gendering processes and, therefore, systematical integration of individual level initiatives with the initiatives for institutional and cultural change. This requires targeting not only individual women and addressing their needs and gender composition, but also challenge the mechanisms that produce inequalities within scientific professions, including the deeply embedded images of ideal workers and associated symbols and ideologies (Morimoto et. al. 2013; Mühlenbruch, Jochimsen 2013)[7]. In this context it is argued that “simplistic, ad hoc or piecemeal solutions cannot eradicate systematic, historical, and widespread gender underrepresentation and inequalities” (Bilimoria, Liang 2012: 6). Instead, it seems inevitable to fundamentally change “how an organization conducts its day-to-day operations (who we are), as well as how the organization views itself in the future (who we want to be).” (Bilimoria, Lang 2012: 6)

Secondly, it is argued that the policies on gender equality in research and science should set gender-related targets, for example with regard to vertical segregation and the share of women in decision-making committees (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010; Lipinsky 2014; EIGE 2016).

Therefore, thirdly, it might be necessary that these policies include (temporary) special measures “to overcome the effect of historical discrimination and accelerate the attainment of substantive equality for women” (UNDP 2014: 33). Special measures – named also specific or positive measures – refer to all actions “aimed at favoring access by members of certain categories of people, in this particular case, women, to rights which they are guaranteed, to the same extent as members of other categories, in this particular case, men” (EIGE Gender Equality Glossary and Thesaurus). They encompass “a wide variety of legislative, executive, administrative and other regulatory instruments, policies and practices, such as outreach or support programmes; allocation and/or reallocation of resources; preferential treatment; targeted recruitment, hiring and promotion; numerical goals connected with time frames; and quota systems” (CEDAW 2004). Among these instruments there are both soft and hard measures. Soft measures include normative pressure, encouragement, guidelines, recommendations and targets initiated by external stakeholders (such as national governments and international organizations) and research organizations themselves. They are collected in various documents, including the European Charter for Researchers and Code of Conduct for their recruitment, LERU’s self-commitment to act against gender bias, the Athena Swan Charter, or Talent to the Top-Charter (Lipinsky 2014). However, so far it remains unclear whether these incentive programmes bring about sustainable changes in recruitment procedures and diminish gender bias in faculty recruitment (Lipinsky 2014: 25). Therefore, while voluntary targets can achieve much, binding regulations and hard measures are believed to be the only way to effect change in some cases. These include legislative quotas used as a measure to counter the underrepresentation of women scientists in decision-making positions in research organizations (Rees 2002; Mühlenbruch, Jochimsen 2013).

Fourthly, it is acknowledged that gender equality policies should be a multi-actor responsibility as regards formulating priorities, supporting institutions with implementation, assessment of performance and continuous monitoring. There should be well established collaboration between science policy-makers, research performers and research funding

[7] The rationale for this effort is that organizations – including academia – are “not simply neutral arenas in which (pre-existing) gendered relations are played out, but a crucial element in ongoing constructions and reconstructions of gendered identities, experiences, and relationships” (Garforth, Kerr 2009: 380).

organizations (Lipinski 2014; see also Verloo et al. 2011). At the same time, there should be agreement between the institution's leadership and associated departments or institutes (Lipinski 2014; Morimoto et. al. 2013).

Fifthly, it is underlined that gender equality polices should have human, financial and institutional resources necessary for implementation, monitoring and enforcement of laws (Verloo et al. 2011; EIGE 2016). In this context it has been found that gender equality committees that operate on the national level or in the organizations of higher education "tend to be equipped with advisory tasks rather than broader decision-making competences" (Lipinsky 2014: 18). Similarly in other contexts, including engineering organizations, it has been revealed that lack of funding and other resources remained a major obstacle to change (Lee, Faulkner, Alemany 2010).

Sixthly, it is argued that the policies should be embedded into existing structures and management procedures, which will ensure institutional change towards gender equality and strengthen the sustainability of planned measures. Simultaneously, it will guarantee the incorporation of gender-sensitive and gender-specific actions into standard management procedures (e.g. gender training or gender-sensitive recruitment, EIGE 2016).

Seventhly, gender equality policies should be accountable and transparent in their goals. Accountability refers to "aligning interventions targeting different institutional levels in accordance with a broader plan for institutional change" and – in case of universities – "considering the incongruous aspects of the academic bureaucracy" (Morimoto et. al. 2014: 410)[8]. Transparency means that "changes in policy, including reformulations of existing policies, must be transparent to faculty at all levels and implemented in a consistent and clear manner. Otherwise the uneven nature of change processes will likely reproduce patterns of inequality: men will use their existing networks to navigate changes, while women will have to simultaneously navigate changes and build their professional networks" (Morimoto et. al. 2013: 411).

Eighthly, gender equality plans should be flexible and resilient as this allows "for the reassessment of gender-specific priorities for the institution at different levels" and for "the adaptation and reshaping of gender equality measures, in cooperation with (the growing circles of) stakeholders, based on insights and/or data in order to ensure that targets and objectives are achieved" (EIGE 2016: 1). In other words, action plans should be kept "open to new needs and opportunities" (Cacace 2015: ix).

Ninthly, policies should be adequately publicized and promoted so that all stakeholders know about existing policies and procedures; "It is not enough if a policy is 'on the books'; organisations need to follow through by making staff aware of specific measures and creating opportunities to discuss any questions or issues they may have" (Lee, Faulkner, Alemany 2010: 91; see also McGregor, Bazi 2007).

[8] It has been argued that universities have "a unique bureaucratic and power structure that creates specific challenges to equity efforts" (Morimoto et. al., 2013: 399). The structure is characterized by the combination of formalized institutional-level policies and procedures with decentralization and relative independence of faculty members. Therefore gendering in academic institutions occurs along departmental, college, and university levels (Morimoto et. al., 2013: 409).

2. Monitoring of gender equality policies and sustainability of gender equality gains

This subsection covers the discussion on the facilitators of effective monitoring systems implemented in an organization to assess where gender equality actions are needed and whether the adopted policies have been successful.

Development of monitoring and evaluation practices is an important aspect of gender equality plans in research organizations. Monitoring increases the robustness and sustainability of gender equality strategies, provides visibility and enables measuring actual progress. It allows not only for assessing program effectiveness but also for drawing upon lessons learnt from implemented initiatives and helps identify areas for further improvement (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010; European Commission 2012a; Lipinsky 2014; EIGE 2016). Monitoring of gender equality policies is also essential because "the effects of a given organizational practice often vary—across social groups, organizational levels, labor markets, and industries" (Tolbert, Castilla 2017: 7) and not all measures intended to promote equity in organizations succeed in doing so (compare Kalev et.al. 2006; Castilla, Benard 2010; Kalinoski et.al. 2013; Tolbert, Castilla 2017). These findings suggest that "the quest for 'best practices'— connoting ones that yield positive results across the board and under all conditions—is a quixotic one"(Tolbert, Castilla 2017: 12).

Mechanisms of monitoring gender equality policies in science and research vary considerably throughout Europe. Monitoring is performed by different parties, most often by governmental bodies, but also research organizations themselves, NGOs or some institutions on own status. Monitoring strategies range from relying only on HR statistics to depending on a combination of activity reports and HR statistics. Other instruments are less established. They include so-called 'income reports' providing details on gender pay gaps, which e.g. all Austrian public institutions including universities are obliged to provide every year. It has been demonstrated that "monitoring instruments (regular reporting, performance indicators, human resources statistics, etc.) depend on the type of organisation and can vary within a national science system; within the institutional setting it can also vary by department" (Lipinsky 2014: 20).

While it is agreed that valid indicators to measure the institutional and cultural change should be created, there is also a conviction that progress towards gender equality in research is difficult to monitor. A difficulty in creating valid indicators for measuring institutional change processes relates to the existing differences in size and research objectives between specialized research institutions (e.g. technical institutes, internationally renowned science organizations, small teaching universities, internationally leading research universities etc.), which "makes it very complex to directly compare institutional performance and outcomes beyond sex-disaggregated human resources statistics" (Lipinsky 2014: 11).

Nevertheless a few recommendations for monitoring and evaluating processes can be formulated. Firstly, monitoring should be exercised by RFO's and RPO's themselves, but <u>coordinated centrally and controlled</u> by civil society actors, including scientific and professional societies (creation of a cross-university, inter-institution monitoring body - Committee on ... 2006a; Lee, Faulkner, Alemany 2010). Secondly, monitoring should <u>include a variety of tools</u>, including HR statistics, performance indicators, activity reports and budget reports. Statistics can be developed into equality indicators, which allow the measurement of change as policies are introduced (European Commission 2012a; Science Europe 2017)[9].

[9] In this context it is worth mentioning the postulate of harmonization of data on R&D personnel to be comparable between countries within EU (European Commission 2003).

Thirdly, progress needs to be measured and benchmarked against other institutions (European Commission 2012a)[10]. Fourthly, policy evaluations should focus not only on the successes of specific policy measures, but also on shortfalls and unintended effects (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010; European Commission 2012a; Lipinsky 2014; Wharton 2015). "A common understanding of the functions and constraints of evaluation exercises in relation to gender equality measures and policies is a reasonable means for enabling real advancements in policy and practice" (Lipinsky 2014: 18). The problem of unintended consequences of change should also be recognized, because "well-intentioned and planned organizational change can be resisted, deflected, or transformed in ways that undermine rather than facilitate desired outcomes" (Wharton 2015: 12). Fifthly, results of monitoring should be disseminated, made public and visible (Committee on … 2007; McGregor, Bazi 2007: 70-72; European Commission 2012a: 39). Sixthly, instances of good practice could be rewarded and made visible for others to learn from, through national or employer-level prizes (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010).

Sustainability refers to all measures taken to ensure that the undertaken efforts are integrated in the organization's long-term planning. When it comes to providing for the future sustainability of the actions initiated under a gender equality programme, dynamic planning is necessary. The results of the STAGES[11] project showed that "the quest for sustainability starts from the very beginning, through the arrangements which are setup for implementation, which are then progressively scrutinised to get to viable solutions for securing their continuity" (Cacace 2015: ix). While some actions may become sustainable from the start, other will need to be redefined, modified, merged or otherwise transformed. Additionally, transition phases may be needed, "where the teams still continue to cooperate in the delivery of the action by gradually reducing their efforts as new institutional actors take over." (Cacace 2015: ix).

It has been also observed that sustainability and resilience of gains related to gender equality can be easily challenged by a number of factors, such as change of leadership, budget cutbacks, or apathy. Therefore, certain steps to avoid reduced or limited sustainability should be taken. Firstly, it is necessary to "embed a commitment to both gender equality and the work related to the Gender Equality Plan into multiple organisational structures. This means that support, buy-in and commitment for the Plan will need to be sought from multiple stakeholders and not only allocated to a specific school or department" (EIGE 2016: 3). Secondly, in order to make gender equality a long-term objective it is essential to incorporate gender equality perspective and aims into the institution's steering documents, including the long-standing development strategy (Swedish Secretariat for Gender Research 2016) and "allocate gender equality work to a specific multi-annual budget" (EIGE 2016: 3). Thirdly, it is important to "create and implement regular accountability, monitoring and evaluation structures, and/or tools into a Gender Equality Plan to flag when sustainability begins to lag and to indicate actions needed prior to crisis points being reached" (EIGE 2016: 3).

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[10] Benchmarking can be understood as "a permanent process of learning and continuous quality improvement through the identification, understanding and adaptation of practices of other organisations" (cit. after: Cacace 2009: 228).

[11] The European project "Structural transformation to achieve gender equality in science – STAGES", funded by the European Commission under the 7th Framework Programme and co-funded by the Italian Government aimed at launching "strategies for structural change in research organisations to address the many and interconnected layers of the problem of gender inequality in science from an integrated perspective" (Cacace 2015: v).

It has also been suggested that to bring about sustainable changes towards gender equality in science and research, it may not be enough to have incentive programs and the voluntary use of “soft measures” to counter gender imbalances (Lipinsky 2014). Setting fixed targets with deadlines and binding obligations may be necessary[12] (Mühlenbruch, Jochimsen 2013).

3. Gender balance in gate-keeping positions and empowering gender equality bodies

Increasing women’s participation in decision-making bodies and equipping gender equality related boards with enough power to effect change are the further conditions of structural integration of gender equality in science. This subsection covers the evidence on how to efficiently and sustainably achieve gender balance in all relevant boards, bodies and committees, as well as the conditions of effective performance of gender equality office.

It is a well-established argument that efficient gender equality strategies should aim at increasing the number of women in scientific ‘gate-keeping’ positions. Gate-keeping refers to the control of the definition of merit and the means of exercising academic power, influencing or controlling “the access to a particular scientific field, allocation of resources and information flows, content and development of a field, and external image of a field” (cit. after Kalpazidou Schmidt 2012: n. p.). Hence, gate-keeping positions include not only the top management of research institutions and evaluation panels of research funding agencies but also “committees which set the research agenda, are involved in the shaping of the future of their institution by hiring new researchers and teachers, serve as tutors for Master’s and PhD students or have a high visibility, such as: strategy committees of national science foundations, national academies, academic and research institutions or advisory boards of research and/or education ministries or the European Commission; hiring committees for faculty and research positions, but more especially also committees who make decisions and/or recommendations on leading research positions; tenure and promotion committees; PhD committees; committees for (re) designing curricula; review boards for research proposals, review boards of journals; prize committees; programme committees which decide on whom to invite as (key note) speakers” (European Commission 2012a: 31).

The presence of a critical mass of women in decision-making roles is believed to be one of the factors of enabling environment for advancing gender equality in science (McGregor, Bazi 2007: 24) and in the society as a whole (Williams, Diaz, Gebbie, El-Sayed 2005). It is argued that increasing the proportion of women in leadership positions not only increases visibility of female scientists and gives them “opportunity to influence others and affect scientific policy”, but also enhances health of scientific disciplines themselves through “draw(ing) on the widest possible spectrum of talented individuals from both genders”, assuring diversity of views and leadership styles and improving the research environment (Williams, Diaz, Gebbie, El-Sayed 2005: 16). It is also argued that better presence and visibility of women in decision-making bodies should counteract biases against female scientists, support gradual changes in stereotypes and encourage other women to pursue scientific career and to aspire to leading positions in science (Rees 2001: 58; European Commission 2008a: 27). Therefore, the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (2005: 25) urges that selection committees bring “together diverse expertise and competences and should have an adequate gender balance (...).” However, at the same time it

[12] For example while the European Commission proposed in 2004 to set targets for women's representation in science at the national level of the EU Member States (to increase the number of women in leading positions in public research to 25% by 2010, and the proportion of female new recruitments to at least 33% by 2010), there were no deadlines for achieving these proposed targets (Sretenova 2010: 12)

is urged that "persons with disproportionate committee and administrative duties should be provided with additional research and support staff or reduced teaching assignments to ensure that their research does not suffer" (European Commission 2012a: 31).

Introducing quotas is one of the methods for achieving gender balance and counteracting sexist hiring which has been for long argued to be an important cause of the underrepresentation of women in academic science (Shen 2013; Williams, Ceci 2015). Quota – as well as target – regulations have been implemented throughout Europe to decision-making, such as scientific committees, advisory boards, expert groups, university governing bodies, etc. Yet they have been less often used to staff recruitment or fellowship awarding (Lipinsky 2014: 12)[13]. However, the suitability of quotas for science has been debated. It is argued that in "academia, where merit and autonomy have a central value, sanctions and incentives" applied to quotas "could be seen as compromising either, and therefore corrupting the system" (Wallon et.al., 2015: 16; see also Laas 2007; Vernos 2013; EIGE 2016). Additionally, it is debatable whether more women in various committees and boards will increase female representation in science and their promotion. Evidence from promotions in the Spanish public university system proves that while in exams to full professor positions evaluators tended to favor same-sex candidates who belong to their own academic network, in exams to associate professor positions, both male and female evaluators tended to prefer male candidates. Moreover, the gender gap was larger, when candidates were evaluated by a female associate professor from their own institution (Zinovyeva, Bagues 2011; see also Młodożeniec, Knapińska 2013). At the same time data from hiring experiments carried out lately in the USA showed that when men and women faculty members evaluated hypothetical female and male applicants for assistant professorships in biology, engineering, economics, and psychology, they "preferred female applicants 2:1 over identically qualified males with matching lifestyles (single, married, divorced), with the exception of male economists, who showed no gender preference" (Williams, Ceci 2015: 5360). Therefore it is argued, that "mechanism resulting in women's underrepresentation today may lie more on the supply side, in women's decisions not to apply, than on the demand side, in antifemale bias in hiring" (Williams, Ceci 2015: 5365). At the same time it has been acknowledged that while real-world data challenge the image of STEM as an inhospitable male bastion, the image itself is self-perpetuating and may discouraged potential female applicants (William, Ceci 2015: 5365). Therefore, while the results of this study may prove the elimination of gender bias and sexism in hiring in the STEM fields, they surely need replication both outside the American context, in reference to other than assistant professorship career stages, inside non-university research organizations and specifically in the field of physics.

The results of the studies on the impact of gender composition of decision-making bodies on hiring and promotion practices are ambiguous. At the same time, they validate the claim that members of such bodies – regardless of their sex – need to be able to address their own biases and make informed decisions, which often requires taking part in gender-awareness trainings. The arguments for such trainings as an important element of gender equality programmes in science are developed in the next sections of this paper.

Transparency and fairness of selection procedures are less disputable conditions for gender balance in decision-making bodies. It is recognized that "open, transparent procedures work

[13] One of the exception is the European Commission, which in 1999 already set a 40% target not only for all committees and advisory boards, but also Marie Curie-Skłodowska Fellowships. A number of German research organizations (including Helmholtz Association, Friedrich-AlexanderUniversität Erlangen-Nürnberg (FAU) and German Leibniz Association) has introduced to their gender action plans quotas based on a cascade model.

to lessen the influence of informal old-boy networks that often exclude women" (European Commission 2008a: 29). However, the reality fall short of the recommendation for transparent and fair procedures. In 2012 it was observed that in many European scientific institutions both structures and processes lacked clarity (European Commission 2012a: 20). It manifested itself in: 1. the lack of clarity about how committees or advisory bodies function and are constituted, 2. establishing membership in such bodies through existing members bringing in acquaintances (co-optation), 3. insufficient information on vacancies and application procedures in the openings to such bodies, and 4. lack of limits for service periods on such bodies and committees, which is believed to prevent the influx of fresh ideas and new perspectives (European Commission 2012a: 20). The persistence of informal and not transparent recruitment procedures sustains male dominance in editorial boards, peer panels, and selection committees for professorships and, therefore, reproduces the established power system of science (Kalpazidou Schmidt 2012). Therefore "it is advisable that the terms for membership on committees and boards be limited to an appropriate duration in order to avoid stagnation. The working conditions of such committees and boards should be published and the criteria of how procedures are structured and how decisions are reached should be transparent and objective: there should be no doubts as to how and where decisions are reached. A regular review of processes and gender audits of such bodies ensures accountability and leads to increased transparency" (European Commission 2012a: 32-33).

Analogic conclusions were drawn from cyclical observations of evaluation process in the Swedish Research Council, a central government agency tasked with funding basic research of the highest scientific quality. The researchers carrying out these studies found "that when various informal structures or unstated assessment criteria have an influence on the evaluation process, this has an adverse effect on gender equality." (Ahlqvist et. al. 2015: 21; see also Ahlqvist et. al. 2013). Hence, they formulated a number of detailed recommendations aimed at greater formalization and clarification of the whole process. The recommendations included, but were not limited to: 1. Striving for an even gender composition of every evaluation panel, and for international representation, 2. developing procedures for the use of pre-determined seating arrangements to promote a good discussion climate, 3. drawing up explicit guidelines for the structure of evaluation meetings, 4. clarifing the roles and responsibilities of the chair and producing clear instructions for how the meeting should be conducted, 5. reviewing the instructions and the information provided to the reviewers during recruitment as well as instructions and procedures for screening meetings from a gender equality perspective, 6. developing training on gender equality issues that is mandatory for all who participate in the evaluation, 7. clarifing the evaluation criteria of „aplicants's merit" and independance, and 8. developing guidelines for the use and calibration of the grades (Ahlqvist et.al. 2015; see also Vinkenburg 2017).

A well-equipped and well-located gender equality body (e.g. a dedicated unit, working group, team, or office) has been identified as a success factor to promote gender equality through institutional change in research and higher education settings. Such a body coordinates and monitors gender equality efforts and ensures the implementation of gender equality actions with the support of and in cooperation with leadership and executive bodies (e.g. human resources department). It also ensures that human resources, knowledge and expertise are available in-house (EIGE 2016: 1). To ensure resilience and impact of gender equality efforts, the gender equality unit heads "should have a title which fully expresses their proximity to the governing body, and they should preferably be chosen from amongst the faculty or be prominent leaders of research groups who continue their main activities in teaching and research on par with their peers. Therefore it goes without saying that adequate and permanent resources should be made available to them, both regarding staff who are experts in gender issues as well as a budget which will allow for activities (…)" (European Commission 2012a: 27).

4. Recommendations and good practices

This subsection summarizes main recommendations concerning structural integration of gender equality in research organizations in the subfields of policies, monitoring, sustainability, scientific gate-keeping positions and gender equality body. Where possible, examples of good practices utilizing these recommendations are described.

According to the results of literature review policies on gender equality in research should:

- have supportive and harmonized national legislative and policy frameworks that are in compliance with international standards and guidelines (European Commission 2003; McGregor, Bazi 2007; Verloo et al. 2011; European Commission 2012a, 2012b; Lipinsky 2014; UNDP 2014)
- be supported with political will and commitment at the highest level (McGregor, Bazi 2007; Lipinsky 2014)
- be comprehensive and tailored, which mean:
  1. relating to various aspects of gender inequality in the institutions,
  2. employing a wide range of short, medium and long-term initiatives, which will be implemented at various institutional levels,
  3. tackling both surface and deep levels of gendering processes and, therefore, systematical integration of individual level initiatives with the initiatives for institutional and cultural change,
  4. depending on national, local and institutional contexts (Lee, Faulkner, Alemany 2010; Morimoto et. al. 2013; Mühlenbruch, Jochimsen 2013; Lipinsky 2014; Pépin et.al. 2014;).
- set gender-related targets (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010; Lipinsky 2014; EIGE 2016)
- include (temporary) special measures (Rees 2002; CEDAW 2004; Mühlenbruch, Jochimsen 2013; Lipinsky 2014; UNDP 2014)
- be a multi-actor responsibility (Morimoto et. al. 2013; Lipinski 2014; see also Verloo et al. 2011)
- have human, financial and institutional resources necessary for implementation, monitoring and enforcement of laws (Lee, Faulkner, Alemany 2010; Verloo et al. 2011; Lipinsky 2014; EIGE 2016)
- be embedded into existing structures and management procedures (EIGE 2016)
- be accountable and transparent in their goals (Morimoto et. al. 2013)
- be flexible and resilient (Cacace 2015; EIGE 2016)
- be adequately publicized and promoted (Lee, Faulkner, Alemany 2010; McGregor, Bazi 2007).

Examples of good practices include:

CNRS (France): the Transformative Gender Action Plan (T-GAP) was constructed "as a flexible scheme to be adapted through discussions with the local implementation teams, with CNRS Senior Management, as well as following reviews and assessment carried out by the external evaluator. Based on the collected quantitative and qualitative data, the devised T-GAP takes into account the recent evolution of the national legislative and regulatory context as well as European recommendations and good practices already implemented by peer institutions in Europe and North America" (Pépin et.al. 2014: 5); gender equality contact points are to be created in all CNRS regional delegations located over the country; a comprehensive collection of sex-disaggregated statistics ("parity" booklet) is being published yearly and disseminated broadly across CNRS, serving as a model for other national research organisations as well as French universities. Tailored data factsheets have been also prepared for recruitment and promotion juries (Pépin et.al. 2014).

Monitoring of policies on gender equality in research should:

- be coordinated centrally and controlled by civil society actors (Committee on ... 2006a; Lee, Faulkner, Alemany 2010)
- include a variety of tools (European Commission 2012a)
- measure and benchmark progress against other institutions (European Commission 2012a)
- focus not only on the successes of specific policy measures, but also on shortfalls and unintended effects (McGregor, Bazi 2007 ; Lee, Faulkner, Alemany 2010; European Commission 2012a, Lipinsky 2014, Wharton 2015)
- results of monitoring should be disseminated, made public and visible (Committee on … 2007; McGregor, Bazi 2007; European Commission 2012a: 39)
- instances of good practice could be rewarded and made visible for others to learn from, through national or employer-level prizes (McGregor, Bazi 2007; Lee, Faulkner, Alemany 2010).

Examples of good practices include:

University of Ferrara (Italy):The "Bilancio di Genere" ("Counting Gender" Report) aims at, most importantly, monitoring the participation of women in the organisation among students, professors, clerical workers and all decision-making bodies, and evaluation of Positive Action Plan implemented at the university. It is considered a national best practice and the university has been granted funding to prepare a guidelines for other institutions to implement in Italy similar practice. It would ease gathering statistical information on the theme across the country. http://www.unife.it/progetto/equality-and-diversity/bilancio

Ensuring sustainability of policies on gender equality in research requires:

- dynamic planning (Cacace 2015)
- embedding a commitment to both gender equality and the work related to the Gender Equality Plan into multiple organisational structures (EIGE 2016)
- incorporating gender equality perspective and aims into the institution's steering documents, including the long-standing development strategy (Swedish Secretariat for Gender Research 2016)
- allocating gender equality work to a specific multi-annual budget" (EIGE 2016)

- implementing regular accountability, monitoring and evaluation structures, and/or tools into a GEP to flag when sustainability begins to lag and to indicate actions needed prior to crisis points being reached (EIGE 2016)
- setting fixed targets with deadlines and binding obligations (Mühlenbruch, Jochimsen 2013).

Achieving gender balance in gate-keeping positions:

- requires that persons with disproportionate committee and administrative duties be provided with additional research and support staff or reduced teaching assignments (European Commission 2012a)
- may require introducing quotas, however their impact on substantive gender equality needs further verification
- requires breaking the persistence of informal and not transparent recruitment procedures (Kalpazidou Schmidt 2012; European Commission 2008a; European Commission 2012a)
- requires that terms for membership on committees and boards be limited to an appropriate duration (European Commission 2012a).

Examples of good practices include:

Siauliai University (Lithuania). Considering the striking underrepresentation of women in the university's Council, the Council Election Tactics and Strategy Plan were developed within the EU-funded structural change project INTEGER in order to encourage a gender-balanced representation of the Council. Several activities were undertaken in order to empower female candidates to run in the university's Council elections, such as: communication with the highest management staff at SU through formal meetings; consultation with the university lawyer about the possible ways of making women's representation in the Council's election; participation in the preparation of the election regulations; search for women candidates from SU representatives according to criteria such as loyalty to the university and commitment to implement gender equality at the university. As a result of these initiatives, the number of women to the Council significantly increased from 0% in 2011 to 36.3% in 2014 (http://eige.europa.eu/gender-mainstreaming/tools-methods/gear/legislative-policy-backgrounds/lithuania).

The Helmholtz Association (Germany): The Helmholtz Mentoring Programme for young women is an integral part of the Association's strategy to ensure equal opportunities for men and women at all Helmholtz Centres. It aims to raise the number of women in executive-level positions, where they are still significantly underrepresented (https://www.helmholtz.de/en/jobs_talent/funding_programs/helmholtz_mentoring_programme/).

Ghent University (Belgium) – Procedure of the election of the Board. As a result of introduction of a new procedure which requires 40/60 % gender-balanced representation of members the Board of Governors (Raad van Bestuur), the University of Ghent achieved balanced representation of men and women as a result of elections in 2014. As new regulations state, each faculty is required to propose at least 1 male and 1 female candidate, and in case there is unequal representation as a result of election, the "candidate with the least votes from the overrepresented sex (compared to other faculties) has to give way to the faculty's candidate of the other sex with the highest number of votes." Interestingly, it was men not women who was at the end positively discriminated (a women had to give way to men). The Flemish law and policies oblige public universities to assure representation of 1/3 to 2/3 of men and women in all the decision-making, advisory and expert bodies (http://eige.europa.eu/gender-mainstreaming/good-practices/belgium/new-election-procedure-board-ghent-university).

Finally, the gender equality unit within the organization should be:

- placed in close proximity to the governing body
- headed by people recruited from amongst the staff/the faculty who continue their activities in research and/or teaching
- equipped with adequate and permanent resources, both expertise and a budget (European Commission 2012a).

Examples of good practices include:

Kapodistrian University of Athens (Greece). The Gender Equality Office (established in 2012) is in charge of gathering gender statistical data on scientific and administrative staff and students of the University of Athens, writing Annual Reports reflecting on the statistics collected, and reporting on the progress towards gender equality (including the universities' policies and practices). The website of the Office is systematically updated in order to inform the university community about the activities of the Office, as well as relevant scientific activity of other universities and research organizations. The office's website constitutes a channel of communication between faculty members and students on issues related to gender equality in higher education and provides self-learning tools for gender studies and issues from a gender perspective. However, the office is facing problems due to the lack of budget and staff (EIGE Greece Promoting Gender Equality In Research - Initiatives For Gender Equality By Research Performing Organizations (http://eige.europa.eu/gender-mainstreaming/tools-methods/gear/legislative-policy-backgrounds/greece).

University of Luxemburg (Luxemburg): Gender delegate: Since 2003, the gender delegate advices the rectorate of the University in all matters relating to gender equality. The activities are based upon three pillars: Development and implementation of infrastructural measures, promotion of gender research, implementation of the gender aspect in academic teaching. The overarching aim is to create a new gender culture enabling equal, respectful and supportive interactions beyond all discrimination, between all genders, studying and working at the University of Luxembourg (http://wwwen.uni.lu/university/about_the_university/organisation_chart/organisation_chart_rectorate_central_administration/gender_delegate/reports_statistics_and_other_documents).

The CERCA Institute (Spain). http://cerca.cat/en/women-in-science/ The Equal Opportunities and Diversity Management Committee has proposed an Equality Plan based on the analysis of statistical data (on women's participation, women's presence in senior positions and others), which commits every center to implement equality and diversity plan (paying special attention to gender and ethnic diversity). Four areas of actions are mostly important:

- Leadership, vision and strategy in CERCA centres (e.g. in each center there is a person responsible for diversity management, equal participation in conferences of men and women, women present in executive and scientific boards)
- Recruitment, promotion and the organisation of work. Measures to prevent bias.
- Encouraging gender awareness in research.
- Accountability and monitoring.(.e.g "Ensuring the indicators and statistics collected by the CERCA centres are broken down by gender, in particular data on governance, research and administration.", inclusion of the theme in the centers' annual reports) (CERCA Institute 2014).

CUG (Italy). The Unique Guarantee Committee for Equal Opportunities in Public Administrations for workers' wellbeing and against discrimination (CUG), since 2011, all public institutions, universities included, are committed through national legislation to create CUG (presicely: Comitati Unici di Garanzia per le pari opportunità, la valorizzazione del benessere di chi lavora e contro le discriminazioni), being the committees which are occupied with equal opportunities, well-being of employees and anti-discrimination. The general aims of CUG are the following:

- Making proposals or designing actions: e.g. of action plans, promotional actions, analysis and creation of programmes, actions to improve working conditions, acts for prevention of discrimination, violence, mobbing, gender budgeting
- Consultation: about administrative acts of the institutions
- Verification: if there exist discrimination, mobbing, etc.

Consiglio Nazionale delle Ricerche (Italy). National Research Council of Italy includes in its strategic document with 3 year programme (2014 -2016) specific priorities linked to gender equality – and declares to sustain the functioning of the CUG (Committees for Equal Opportunities… described above). The programme points to certain activities of the Council:

- Spreading knowledge on gender and gathering statistics, leading research on the theme
- Career monitoring of the employees in order to identify gender discrimination
- Actions to combat discrimination, also of a cultural character that hinder realization of equal opportunities at work
- Action to stop introduction of discriminatory regulations or laws
- Improving job conditions so they are gender-friendly, developing flexible work conditions, support to institutional care in organisations, reducing "gender-linked risk"
- Supporting women scientists and their participation
- Gender balance in governing bodies, committee, examining bodies (1/3 of women)
- Promotion of gender budgeting.

Istituto Nazionale di Fisica Nucleare (INFN) (Italy). The National Institute for Nucleare Physics of Italy has recognized the CUG in its Statute as an Internal Organism of working. From 2002 INFN has developed an three-year Affirmative Action Plan. The current one is based on the European document (European Commission 2012a), on the Report on the Organizational well-being and on the gender audit report of GENISLAB project. The general objectives of this Action Plan are:

- to increase the transparency of decision-making processes and to increase the information flow;

- to remove the unconscious biases form institutional practices;
- to promote excellence through the promotion of diversity;
- to improve research through the integration of a gender perspective;
- to modernize the personnel management and the working environment.

Chapter II All-hands-on-deck: organizational leadership and beyond

As the effectiveness of gender equality efforts depends greatly on genuine support and engagement from all stakeholders, this section covers the discussion on how to attain and sustain this support both inside and outside the scientific institutions. It refers to the GENERA "Engaging Leadership" Field of action". Accordingly, the role of leadership in making gender equality a vital aspect of the research organization's policy and approach as well as the mechanisms for enhancing the leaders' responsibility for gender equality efforts are firstly discussed. Secondly, vital categories of stakeholders inside and outside research organizations are identified and the factors that influence their attitudes towards gender equality programmes are debated.

1. Leadership Accountability

Establishing clear leadership and responsibility for organizational change are believed to be critical to the success of gender mainstreaming and the equality initiatives in the workplace (Rao, Kelleher 2005; Kalev et.al. 2006; Sturm 2006; European Commission 2012a; Bleijenbergh, Van Engen 2015; McClelland, Holland 2015; Wharton 2015; Graham at.al. 2017; Vinkenburg 2017). It is argued that "only an observable full commitment of an institution's governing body will guarantee the long-lasting effect of a gender policy since this proximity to 'power' prevents a gender policy from becoming just another policy paper, guaranteeing that the policy is actually carried out, is continuously tested against 'reality' and adapted to changing needs and challenges by implementing new measures" (European Commission 2012a: 27)[14]. As a consequence, establishing clear organizational responsibility for diversity, namely intervening into organizational structure, leads to considerable increases in managerial diversity and better effects from initiatives aimed at supporting the agency of individuals, such as diversity training and evaluations, networking, and mentoring (Kalev et.al. 2006; see also Bleijenbergh, Van Engen 2015).The need to win leaders hearts and minds, and overcome their attitudinal barriers to equality and diversity policies is therefore urgent, as it counteracts breeding "a 'compliance' mentality, of 'ticking the boxes', without necessarily generating any real commitment to change or any real understanding of why change is necessary or how to achieve it" (Lee, Faulkner, Alemany 2010: 93). It is argued that interventions – to be effective in promoting diversity in upward mobility systems – should assume active involvement of gatekeepers "as they are power holders and important "carriers" of the belief in meritocracy" (Vinkenburg 2017: 9; see also Bleijenbergh, Van Engen, & Vinkenburg, 2013)[15]. Including gatekeepers in the modeling process increases their commitment, facilitates implementation of interventions and supports the transformation of stakeholders into change agents. Moreover, gatekeepers as problem owners identify particular rather than universal barriers and opportunities to increasing diversity in their own context.

[14] A study based on a sample of 81 large, publicly traded companies in the USA revealed that the hierarchical rank of the individual certifying the company's required, confidential federal Equal Employment Opportunity (EEO) report – rather than the presence of an HR executive on the top management team – translate into enhanced gender diversity in management (Graham at.al. 2017).

[15] The remaing specifications for effective systemic diversity interventions include optimizing decision making and mitigating bias. Engaging gatekeepers and optimizing decizion making through mitigating bias are these kinds of interventions that are especially sutiable for upward mobility career systems with their fixed steps or routes and formal promotion criteria—such as in academia (Vinkenburg 2017).

Therefore, getting and keeping gatekeepers on board throughout the course of the intervention is a challenge, but if successful, the impact is palpable" (Vinkenburg 2017: 14).

Leaders regulate discourse through formal and informal mechanisms and play a key role in establishing work climate perception (Dragoni 2005; Wharton 2015). Therefore, through their acceptance or denial of responsibility and their narratives about gender, work and family which are believed to be "a central ingredient in the broader system of practices that reproduce inequality" (Wharton 2015: 16), leaders can heavily influence change efforts in an organization. It has been demonstrated that leaders can deflect personal responsibility for change and deny gender inequality to be structural or systemic by emphasizing the choices made by others, mainly female employees (Wharton 2015) as well as by referring to meritocracy[16]. Similarly, some policies – including the work-family policies – may face resistance or indifference among key organizational gatekeepers, such as managers or supervisors. Meanwhile, workers who may want to use these policies avoid doing so, as they recognize that their employer's commitment is more symbolic than real (Blair-Loy and Wharton 2002: 816, Wharton 2015).To avoid such situations, training (up-skilling) of the decision makers, including organizational gatekeepers is vital. It is for example argued that "university leaders should as part of their mandatory overall management efforts hold leadership workshops for deans, department heads, search committee chairs, and other faculty with personnel management responsibilities that include an integrated component on diversity and strategies to overcome bias and gender schemas" (Committee on … 2006a: 7). These workshops should be integrated into the fabric of the management of universities and departments.

The inevitability of leadership training is also expressed in the conclusions of the project PROMETEA, which aimed at identifying common obstacles that inhibit the effective implementation of gender equality and diversity policies in engineering organizations. According to them organizations must get managers on board by not only winning them around to the policy objectives, they must also train them in the techniques or procedures needed to realise those objectives. "A major priority must be to improve line managers' ability to give their staff ongoing guidance and support in career management and development. (…) Explicit training is clearly needed in constructive approaches, to realise the full potential of all staff by building up rather than undermining confidence and horizons[17]. Managers might also be engaged in discussions about how to avoid penalising candidates in promotion rounds for taking periods of parental leave or for working reduced hours in order to care for family members" (Lee, Faulkner, Alemany 2010: 92).

In case of academia leadership, which is multilayered, the role of the departmental leader is identified as critical. Chairs influence many aspects of departmental life, including practices, policies, routines, relationships and dynamics. By doing so, they also shape faculty's satisfaction with their careers, colleagues, and work environment (Wharton 2015: 13). The results of the ADVANCE project revealed that although many departmental leaders were generally supportive of change towards gender equality, "they did not feel that large-scale

[16] Therefore it is essential to change the narratives about gender inequalities in science as a result of private choices of women and to acknowledge it is a public issue and the result of multiply responsibilities and factors including structural, legal/institutional and cultural ones.

[17] However the results of a number of analyses suggest that the effects of diversity training on bias and stereotypes are weak or even counterproductive by generating backlash (comp. Kalev et.al. 2006; see also: Kalinoski et.al. 2013). Kalev et.al. (2006) argue that the effects of training on equality are better when organizations establish responsibility for diversity by assigning responsibility for diversity goals to a specific office, person, or group

organizational or structural correctives were needed, nor did change require significant actions on their part" (Wharton 2015: 15). This attitude, labelled as "passive responsibility" (McClelland, Holland 2015), combines outward support for change with ambivalence about the need to 'challeng[e] existing structures and stereotypes' and a belief that responsibility for change belongs to others rather than oneself" (Wharton 2015: 15; see also Bleijenbergh, Van Engen 2015).

2. Multi-actor engagement

Any change is challenging to achieve and subject of resistance as it threatens existing individual and organizational assumptions about power, role, status and control (Lane 2007: 90). It has been argued that multiple motives – including men's fear of losing even small relative advantages in workplace power and income as well as perceived assault on dignity and masculinity – "can scuttle efforts at organizational change, even when top management is supporting such change" (Acker 2006: 455). In addition to individual fears of loss of current status as well instability, uncertainty and effects on individual time and workload, there are organizational sources of resistance to change, including "a conservative culture, fierce protection of current practices, and prevalence of disciplinary or territorial viewpoints" (Lane 2007: 85). As bureaucratic organizations of all types may resist change, academic institutions are perceived as especially resistant. They are characterized by conservatism in practice, goals, and culture and conservatism is believed to be especially prevalent in the scientific disciplines (Lane 2007: 86; see also Benschop and Brouns 2003).

Since the probability of resistance to change is high, any efforts to enhance the position of women in science – as in any occupations traditionally dominated by men—requires awareness of and support for gender equality and diversity across the whole organization (Lee, Faulkner, Alemany 2010: 96).The lack of the involvement of all the actors inside the organization early in the process was identified as seriously limiting its' results (EIGE 2015, 2016; see also European Commission 2009). Moreover, successful efforts appear to have combined active support from insiders with the actors from outside the organization (Acker 2006: 455).

Involvement of different categories of stakeholders both inside and outside the institution to initiatives promoting gender equality has multiple advantages. It not only reduces resistance to change, but also "creates a feeling of ownership for gender equality actions implementation, allows the combination of different expertise and types of knowledge, guarantees that tasks and responsibilities are shared, allows for reaching different organizational and/or disciplinary staff and departments, increases the commitment and potential impact of gender equality measures, helps achieve sustainable changes institution wide and ensures that the process is more transparent inside and outside the institution" (EIGE 2016: n. p.).

It is argued that to 'make the case' for gender equality and diversity policies at least three steps are necessary. Firstly, "people have to be persuaded that there is indeed inequality" (Lee, Faulkner, Alemany 2010: 94). The point is to encourage open and not trivialising discussions about gender, mainly by providing hard data on retention, attrition and career inequalities to demonstrate the extent of gender imbalances at all levels of the organization[18]. Secondly, “people have to be persuaded that there are good reasons for seeking to change the situation revealed by the data” (Lee, Faulkner, Alemany 2010: 95), as gender imbalances in retention and progression are not exclusively the result of individual choices or gender differences in ability and inclination. Thirdly, “people need to be persuaded of the case for specific gender equality and diversity policies” (Lee, Faulkner, Alemany 2010: 95). This demands raising awareness of how staff members individually, or the wider organization, contribute to enhancing or inhibiting gender equality and highlighting the benefits of specific policy objectives, which often extend beyond gender change (Lee, Faulkner, Alemany 2010: 93)[19]. As far as the stakeholders inside the institution are concerned it is additionally argued that willingness of those of them who have never been exposed to issues related to gender or gender issues in science and technology is critical to acquire (McGregor, Bazi 2007: 24).

In this context it is worth discussing participatory modelling, which a method of institutional intervention which supports stakeholders in tackling an organizational issue. Bleijenbergh and Van Engen (2015) reported on the results of participatory modelling used to support gender equality in two Dutch universities. With the participation of researchers stakeholders were able not only to reach a shared problem understanding and analysis of gender inequality, but also to identify and implement tailored interventions. The involvement of both researchers and stakeholders in the modelling process allowed for integrating professional knowledge on gender inequality in academia with the day-to-day knowledge of organizational stakeholders. Building causal loop diagrams together helped to identify self-reinforcing and interrelated feedback processes – including masculinity of norms, visibility of women and networking of women – which explain gender inequality in organisations. Understanding how these different feedback processes are interrelated helped stakeholders to identify possible interventions to support gender equality. Moreover, including organisational stakeholders in the modelling process increased their commitment to the results and responsibility for gender equality, as well as facilitated implementation of interventions, as “in both universities the boards were quick to accept the outcomes and recommendations, and started developing interventions soon after the projects were rounded off” (Bleijenbergh and Van Engen 2015: 434).

Among the stakeholders outside the institution the role of professional societies and higher education organizations, research founding agencies and governmental institutions is discussed. Professional societies are believed to “have a responsibility to play a leading role in promoting equal treatment of women and men and to demonstrate a commitment to it in their practices” (Committee on ... 2006a: 9). More specifically, the role of scientific and professional societies is at least fivefold. Firstly, they should “serve in helping to set professional and equity standards, collect and disseminate field-wide education and workforce data, and provide professional development training for members that includes a component on bias in evaluation” (Committee on ... 2006a: 9). Secondly, they are supposed to “develop and enforce guidelines to ensure that keynote and other invited speakers at society-sponsored events reflect the diverse membership of the society” (Committee on ... 2006a: 9). Thirdly, professional societies should “ensure reasonable representation of women on editorial boards and in other significant leadership positions” (Committee on ... 2006a: 9). Fourthly, they must “work to ensure that women are recognized for their contributions to the nation’s scientific

[18] In this context it is worth to cite the study which revealed that discussing in a high school physics class the underrepresentation of women in science may lead to an increase in physics identity for female students (Lock, Hazari 2016).

[19] For example, the case for flexible work practices typically points to the benefits for employees of a better work-life balance, and for employers of a healthier and more efficient workforce.

and engineering enterprise through nominations for awards and leadership positions" (Committee on ... 2006a: 9). Last but not least, they should "provide child-care and elder-care grants or subsidies so that their members can attend work-related conferences and meetings". (Committee on … 2006a: 10). A specific role in enhancing gender equality and addressing the issue of gender dimension of knowledge is attributed to women's professional science associations. They are argued to play an important role in articulating the views of women concerning issues of science, acting as fora that highlight the special concern of female perspectives, and women's role in the development of science (McGregor, Bazi 2007: 60).

As far as higher education organizations are concerned, it is advised that they could together form an inter-institution monitoring organization, which would "act as an intermediary between academic institutions and federal agencies in recommending norms and measures, in collecting data, and in cross-institution tracking of compliance and accountability" (Committee on ... 2006a: 9).

The role of all research funding agencies would be to:

- provide workshops to minimize gender bias
- collect, store, and publish composite information on demographics, field, award type and budget request, review score, and funding outcome for all funding applications
- make it possible to use grant money for dependent care expenses necessary to engage in off-site or after-hours research-related activities or to attend work-related conferences and meetings
- create additional funding mechanisms to provide for interim technical or administrative support during a leave of absence related to caregiving
- establish policies for extending grant support for researchers who take a leave of absence due to caregiving responsibilities
- expand support for research on the efficacy of organizational programs designed to reduce gender bias, and for research on bias, prejudice, and stereotype threat, and the role of leadership in achieving gender equity" (Committee on ... 2006a: 10-11).

Finally, the role of governmental agencies would be to:

- move to enforce the national anti-discrimination laws at universities and other higher education institutions through regular compliance reviews and prompt and thorough investigation of discrimination complaints
- evaluate whether universities have engaged in any of the types of discrimination banned under the anti-discrimination laws, including: intentional discrimination, sexual harassment, retaliation, disparate impact discrimination, and failure to maintain required policies and procedures
- encourage and provide technical assistance on how to achieve diversity in university programs and employment. Possible activities include providing technical assistance to educational institutions to help them to comply with the anti-discrimination laws, creating a clearinghouse for dissemination of strategies that have been proven effective, and providing awards and recognition for model university programs (Committee on ... 2006a: 11-12).

3. Recommendations and good practices

This subsection summarizes main recommendations how to attain and sustain this support both inside and outside the scientific institutions. Where possible, examples of good practices utilizing these recommendations are added.

According to the results of the literature review to improve **leadership accountability** for gender equality policies it is necessary to:

- incorporate training on diversity and gender bias into mandatory leadership workshops for staff/faculty with personnel management responsibilities (Committee on … 2006a; see also Science Europe 2017).
- identify and overcome "passive responsibility" of the departmental leaders (McClelland, Holland 2015;Wharton 2015)
- improve managers' ability to give their staff ongoing guidance and support in career management and development (Lee, Faulkner, Alemany 2010)
- sensitize managers to the problem of penalising candidates in promotion rounds for taking periods of parental leave or for working reduced hours in order to care for family members (Lee, Faulkner, Alemany 2010).

Examples of good practices include:

Lund University (Sweden). AKKA – a leadership program with an integrated gender perspective has been established in order to ensure training about gender equality issues to all individuals in leading positions. The program is based on an assumption that academic leaders are gender eguality change leaders in academia (Widén 2011).

University of Duisburg-Essen (Germany). It has a vice-rector for diversity management — the first post of its kind at a German university (Mühlenbruch, Jochimsen 2013).

CNRS (France). The CNRS fostered an establishment of Steering Committee for Gender Equality, ensuring commitment and support from the top-level decision-makers; using top-down power (e.g. by asking the President to invite CNRS decision-makers to INTEGER activities; by asking the CNRS Institute directors to contact their Lab directors); a promotion video, featuring a commitment message from the CNRS President, and showcasing the INTEGER project, was released nationally through various means, including via the weekly CNRS e-newsletter received by all staff working in CNRS joint laboratories (Pépin et.al. 2014).

University of Washington (USA). It has professional development programmes (looking at evaluation bias and mitigating impact) for university administrators, including department chairs (European Commission 2012a).

To raise **engagement of all stakeholders** in the gender equality policies it is necessary to:

- recognize and manage the sites and sources – both individual and organizational – of resistance to change (Lane 2007)
- involve all the actors inside the organization early in the process (EIGE 2015, 2016; European Commission 2009)
- raise awareness of all the actors about 1. the extent of inequalities in the organization (by using hard data), 2. the reasons for seeking to change this situation and benefits of

policy objectives, and 3. the mechanisms of fostering and inhibiting gender equality (Faulkner, Alemany 2010)

- recognize the roles of the stakeholders outside the organization, mainly including: setting standards of gender equality (governmental bodies and professional societies), encouraging, assisting and evaluating the process of implementing gender equality policies by organizations (governmental bodies and professional societies), improving visibility of female researchers (professional societies), financially supporting scientists with care-giving responsibilities (research funding organizations and professional organizations)(Committee on ... 2006a).

Examples of good practices include:

CNRS (France): creation of implementation teams and working groups to best tackle the issue of researchers' recruitment, promotion and rewards procedures and practices, including STRIDE-like Committee (comprising: the Chairs of the different standing peer-review evaluation panels of the "*Comité National*", Deputy Scientific Directors of all CNRS Divisions, HR Officers, senior women researchers and gender experts; proposing concrete measures to improve gender equality and gender balance in the recruitment, promotion and scientific recognition of researchers) and teams including women and men, junior and senior researchers, both CNRS researchers and university faculty; participatory approaches (e.g. through workshops and seminars); creation of ownership (e.g. by undertaking actions proposed by teams); developing peer-to-peer learning by involving external scientific leaders as Ambassadors or representatives of mentoring peer institutions to foster buy-in among researchers (Pépin et.al. 2014).

The Trinity College Dublin (Ireland): expert advice was sought, and availed of, both as an input to the T-GAPs and, via the engagement of guest speakers, as a means of informing the university population and securing buy-in for institutional transformation; The College Implementation Team is responsible for implementing College-wide T-GAPs at an institutional level and making recommendations to College governance. In addition, it provides an essential forum to which matters arising at the School teams which have wider institutional implications, can be referred to and via which they may be addressed (Pépin et.al. 2014).

Swiss Federal Equal Opportunity at Universities Program (Switzerland). For the years 2013-16, the Swiss federal government has dedicated CHF 10 million for the universities' gender equality actions. The goal of the federal program is 25% women professors at Swiss universities, with 40% at the level of assistant professorships, as well as an increased proportion of women in academic leadership positions at universities and related institutions. The federal government provides funding for gender equality actions on the basis of the universities' individual action plans, which must address the issue of gender equality on a structural level in all key areas of activity: teaching, research and community service ((Lipinsky 2014; http://www.gleichstellung.uzh.ch/en/politik/bundesprogramm.html).

Greek Association of University Women (EL.E.GY.P.) (Greece). EL.E.G Y.P. is a non-profit scientific organisation founded in 2008 with the aim to improve the position and status of women in academic institutions of Greece and to promote their scientific work and social contribution. The ELEGYP holds every year a series of events about women in academia. Between 2013 and 2015, ELEGYP implemented an action programme for the "Promotion of a gender perspective and combating gender discrimination in universities" co-financed by the Ministry of Interior. Within the framework of this action programme, many events took place in cooperation and co-organisation with other Greek universities in order to promote the integration of a gender perspective in Greek universities (http://eige.europa.eu/gender-mainstreaming/tools-methods/gear/legislative-policy-backgrounds/greece).

Association of Hungarian Women in Science (Hungary). An association with the objectives of: increasing the ratio, representation and decision-making role of women in scientific research and innovation; analyzing the background and conditions of gender equality in the area of research, technology and innovation; supporting the scientific/technical career of women; awareness raising and changing of public opinion/attitude; contributing to increase the number of the new generation of researchers and engineers; raising the support of women's scientific career to national program level (http://epws.org/interview-of-the-month-association-of-hungarian-women-in-science-012016/).

The TOTAL E-QUALITY Award (Germany). It has been established by the association TOTAL E-QUALITY Deutschland e.V. (since 1996). The association comprises of several German companies, trade unions employers' associations, selected federal ministries and agencies as well as educational organizations. The award is presented to organizations from the private sector, science and administration and associations with a minimum of 15 employees that successfully implement gender equality in their personnel and organization policies. It comprises a certificate and an achievement award for sustainability, in combination with the TOTAL E-QUALITY logo, which can be used by the organizations in all internal and external relations for presentation and image cultivation. Certificates are awarded once a year (https://www.total-e-quality.de/en/).

Chapter III Flexibility, Temporality and Work-Life Balance

This section covers two broad themes of the literature concerned with how women in physics, and female scientists in general, address the issues emerging at the intersection of work and family. As per GENERA Fields of Action, notions of flexibility and time are tied with the work-life balance (WLB), as well as care and family life. More specifically, the works reviewed in this section debate questions around WLB and the solutions that respectively facilitate or hinder the combination of caring duties with a successful career in physics for women.

1. Between laboratory work and flexibility schemes in academia

Research on flexibility addresses two tracks: the general career flexibility linked to taking breaks and returning to academia, and the more challenging provisioning of flexible work conditions for the already hired staff. While the former has to do also with retention and attrition (Ceci, Williams, 2010, 2012), the latter is predominantly linked to accounting for family-life goals under the constraints of working in laboratories. In other words, research on flexibility in the second realm discusses why and how women and men may request or require flexibility of scheduling and types of the tasks assigned to them. In simple terms, this is linked to either being pregnant for women, which necessitates alternative work away from the laboratories in many cases, or, revolves around having children of various ages who require parents' schedules to be aligned with their routines (schooldays, school schedules, pickups, vacations, etc.)

Research on academia has found that faculty work lives are characterized by a high degree of flexibility that may be conducive to more balance within work and family responsibilities (Ward & Wolf-Wendel, 2004). This flexibility theoretically allows academics to choose how to schedule their own days and to set schedules that allow additional time with children (Solomon, 2010; Ward & Wolf-Wendel, 2004), even though this is heterogeneous across different disciplines and offers varied degrees of freedoms. In general, however, academia has been said to entail a great deal of autonomy in choosing work/research topics of interest and, generally, lessening of the need to administratively relay one's schedules to a supervisor or boss (Ward, Wolf-Wendel, 2004).

Scientists may have less access to flexibility in the location of their work than other academics, as their work often must be done on-site and is tied to the work of others in the lab (Fox, 2005, Fox & Mohapatra, 2007; Ward, Wolf-Wendel, 2012). Yet, Damaske and colleagues propose, "there are flexibility benefits specific to a lab, such that a highly trained team can continue work and publish when faculty members are out of the office, or, even on leave, and, as a professor in charge of the lab, faculty members do retain a relatively high level of control over their schedule" (see also Ward & Wolf-Wendel, 2012). In certain institutions, it has been shown that faculty members with access to the "work-redesign model", increases outcomes related to gender mainstreaming and broader organizational culture (Damaske et al. 2014).

Consequently, differently conceived necessity of being flexible as an employee at a modern academia, may introduce both advantages and disadvantages for women and men in family roles. In some cases, it may allow more progressive male scientists to accommodate changing norms of fathering (Damaske, 2014), because if men feel an increased sense of devotion to family as part of their identity and anticipate that academic science does not conflict with such devotion, the structures of gender and care in academia alter. However, if demands on men's remain based on full work-devotion, then work-family conflict is likely to constitute a concern for academic scientists and be, perhaps, a growing factor for men who seek egalitarian partnerships and, effectively, get pushed away from academia.

Flexibility may sometimes be a double-edged sword, ultimately relegating women to the positions of inferiority under the premise of inclusion. This happens, among others, through reducing opportunities for travel, which may impact opportunities for collaboration and research recognition important to success in academia (Tang et al., 1999). In a study of one of the top research company employing scientists, Lewis and Humbert (2010) found inequality that originated from a theoretically gender-empowering fourth-fifths week scheme. Four day week policy, flexible work time arrangements and considerable informal flexibility are accessible to both genders, yet is practically taken exclusively by women who must cope with work-unaligned school-hours. Signing up for this “benefit” signifies a 20% cut in salary, while the workload is retained. In other words, money decreases while work becomes intensified. However, researchers noted, mothers tended to regard this practice very positively and often conceptualize it as an opportunity or a luxury, so it was neither articulated as “bad practice”, nor taken on by the unions. The four day week is thus effectively a full time compressed work week but with an associated loss of salary. Although not formally made explicit, all those interviewed recognized this as an unwritten rule. They accept it because, the ideal worker is constructed as one who is constantly available and visible, conforming to a masculinist organizational culture.

2. Implications of extensive work hours for gender in academia

According to Kidnman and Jones (2008) long working hours, high pressure and work-life imbalances are common in academia. This can negatively affect productivity and worker satisfaction. In addition, researchers exploring gender equity in higher education have looked at the so-called “temporal dimension” of women’s careers, considering “time-in-rank” to be one critical lens through which to assess women’s and men’s career discrepancies (Toren 1993; Ceci, Williams 2014; Misra et al. 2012).

The temporal dimensions showcases that there are significant sex differences in hours worked and lifestyle preferences (Ferriman et al. 2009; Winslow 2010). In addition, these have pronounced gender stratifications over time. Halpern et al. (2007), for example, rely on a survey to infer that intellectually talented men in their mid-30s are on average more career focused, work longer hours, and, more importantly, are willing to work longer hours than women of the same age. Conversely, women report a preference for a more balanced life approach with regard to career, family, and friends (see also Misra et al 2012; Webb et al., 2002). The authors argue that if these sex differences continue over a sustained career timeline, women's additional family responsibilities may help explain some of the underrepresentation of women in science careers (Halpern et al. 2007; Eccles 1994). Eventually, it translates to the profound absence of women at the highest levels of various professional careers. In Halpern terms, “if men remain more career focused and spend more hours working, for whatever the reasons, then, in all likelihood, men will accomplish more than their female counterparts”. While here the explanation seems to cease at the level of shallow obviousness, it is clear that structural temporal factors operate in a much more subtle manner (Blickenstaff 2005). Despite the increasing proportion of women in academe, “significant disparities [are] still present by rank and discipline”, which means that as academic rank and prestige increases so too does the percentage of men in comparison to women.

Coincidently, the structural factors coincide with preferences, as grant funding and periods of award are also generic and – at first glance – gender-neutral. However, non-accounting for temporal constrains of family work in science results in marginalization and precarization of young female scientists, who are often not chosen due to the fear of them not being able to complete work on time as a result of becoming a mother. Same temporally-construed risks are not voiced with regard to men. This is reiterated in the study of work/family conflict by Greenhaus and Beutell (1985). Time-based conflict occurs when time pressures from one role make it impossible to fulfill expectations of another role and experiences of work/family conflict have been found to be positively associated with the number of hours worked per week (ibid). It has been estimated that the average academician works approximately 55 hours per week, which is a much larger than standard 40-hour schedule (see also O'Laughlin, Bischoff 2005). Academics in STEM work substantially longer hours than averages and often extend their hours late into the night (Ecklund & Lincoln, 2011; Wang et al., 2012). Damaske et al. (2014) focus on, male faculty in all academic disciplines, who reportedly work 54.8 hours a week, which signals working over 11 hours more per week than the 43.1 hours averaged by all employed men, and over additional weekly 9 hours when compared to the 46 hours averaged by male professionals or managers (Jacobs, 2004).

The rigid regulations commonly specify a review period that an academic must conform to, yet little focus is placed on the fact that crucial steps for earning tenure, winning a mid-career grant or completing a middle-step degree (habilitation/docenture, etc) coincides with the time of starting families or raising young children. In a time-paradox, "individuals facing tenure review must demonstrate high levels of competence and research productivity in the earliest years of their academic career to avoid losing their jobs" (O'Laughlin, Bischoff 2005:83).

Regardless of the earlier prognosis on the envisioned evolution and impact of e-technology for work environment, Currie and Eveline examined the effects of virtualization of a post-industrial economy and academe for scientists in Australia (2011: 533-534). The authors found that the current climate fails to meet its initial goals of allowing for the work to be done anytime and anywhere, as many academics are tied to their equipment and needed on-site. The time-bind of academic/work and family life has been actually said to worsen, as working conditions progressively called for work that is extended and intensified into private life with longer working hours and generally faster-paced environment. Academics with young children using e-technologies claimed that they had trouble to establish boundaries between work and family, pushed administrative duties to overtime, and, effectively, negatively contributed to family life.

On the same matter of family challenges, Townsend (2002) noted that as long as women remain the primary child care and household managers, they will disproportionately feel the impact of longer work hours, particularly when they are in dual-career relationships. Both men and women in partnerships where partners worked 45 or more hours weekly each, considered themselves significantly less successful in balancing work and family. Upon earning tenure, academics report a reduction of work hours lasting only for mere two years (Jacobs 2004). In other words, dual-academic couples are vulnerable to significant effects of managing overtime and long work hours.

3. Balancing work and family: the significance of gender for caring obligations

As already suggested, WLB policies and instruments are the most popular gender-equality promoting tool across the RPOs surveyed for the European Commission's research. Work–life balance measures, which were largely understood as defining and adhering to parental leave systems and flexible working arrangements, were prevalent (see also Rosser, Lane 2002; O'Laughlin, Bischoff, 2005; Ivie et al. 2011, 2012, 2015, Fox, 2005; Fox et al. 2011; Kinman, Jones 2008). According to EC survey, in 26 out of the 37 countries in the survey, more than half of the responding RPOs had such measures in place in 2013. In all but two countries, at least a third of responding organizations had introduced work–life balance schemes.

When listing explanations of women's underrepresentation in all science-related fields, Ceci and Williams (2010) address fertility choices and home-balance issues as the third prime set of causes. They argue that math-intensive fields experience an exacerbation of the missing gender ratios balance due to the fact that the number of women in these disciplines is smaller to begin with. Even more problematic is the fact that progressively each level of attainment from undergraduate, to graduate education, to tenure-track appointment, witnesses growing attrition.

In part, the imbalance can be explained by Ferriman and colleagues' (2009) claim that on the top math/science graduate students and the profoundly gifted, in which they suggest that employment preferences, life values, and personal views are not concurrent among this category's members, even though they are commonly universalized and assumed to be alike. Further, the authors draw attention to developmental changes and gender differences, first during the phase of emerging adulthood and, then, upon a transition to parenthood for those who opt into having children.

O'Laughlin and Bischoff's study (2005) of over 260 full-time academics in tenure-track positions and with at least one child under the age of 16, sheds light on the salient issues within work/family balance and conflicts. Aside for the time-bind conflicts resulting from the overly excessive numbers of hours worked, academics are also prone to strain-based and behaviour-based conflicts. Strain-based conflict occurs when the stress of one role impacts one's performance in another role, as are the academics who are expected to fulfill multiple role demands within the work setting (e.g. teaching, research, service, consultation, etc.) (ibid: 80; see also Currie, Eveline, 2011). Behaviour-based conflicts occur when behaviours expected in one role are incompatible with behaviours expected in another role. It has to be mentioned that although academic positions generally have the advantage of a flexible work schedule, this flexibility also incurs costs of bringing work home and performing certain tasks in free times – in the evenings or during the weekend. Furthermore, working at home may create behaviour-based conflict, as the focus and energy needed to fulfill work expectations is likely to conflict with demands for attention from children and/or spouses. In turn, overload and stress related to work/family conflict translate to individual health risks and depression as well as business costs of poor morale, decreased productivity, absenteeism, and turnover (Duxbury & Higgins, 1994), or, for a career in academia, could mean lower quality job performance, denial of tenure or promotion, etc.

The results of a global survey of 15 000 physicists worldwide, deployed by the American Institute of Physics, shed light on female scientists home-life burdens. Although many respondents report that chores are shared equally, women are more likely than men to report that they do more of the housework than their spouses or partners. That result holds even if only households in which both partners are employed are taken into account (Ivie, Tesfaye 2012: 49). Global data suggests that male physicists commonly find themselves married to someone who either does not work outside of the home, or, alternatively, earns less money than they do, thus being nominated to shouldering care responsibilities. When family responsibilities do affect physicists' careers, they are more likely to affect women than men because "when push comes to shove and somebody needs to care for a sick child or family member, it makes economic sense for the partner who makes less money to take on that responsibility. And for most men, that partner is someone else" (ibid.: 49). Clearly, this points to lesser reporting of work/family conflicts for men. The findings have been confirmed and/or expanded upon in various studies on women in science (e.g. Ecklund et al. 2012; Fox, 2005, 2010; Mason et al 2013; Whittington 2011; Xie, Shauman, 2003).

In most interviews conducted for a large-scale international project on women in science, Godfroy-Genin (2009) found that family has been depicted as an obstacle to success in STEM research. The perception was that family undermines productivity and commitment, as full availability required by "good" researcher was unattainable to mothers. Beyond the objective impact and the double workload that family creates for many women researchers, family representations translated to divergent gender-research expectations.

Conversely, "top women" in STEM often described family (including broader family, e.g. uncles, aunts, sisters, brothers, parents) and social networks (e.g. friends, colleagues) as the most important support in their career, almost never as a burden (Godfroy, Genin 2009). All top women described very supportive parents and very supportive husbands or partners (Husu and Koskinen, 2008). Three main reasons to explain positive experiences of family life among top female scientists in PROMETEA project were:

1. good organisation thanks to family support, existing facilities or an opportunity to hire help;
2. good timing in combining career and family (many women had children early, some of them when they were students);
3. a no-stress approach to family concerns (women said they were not too perfectionist in household management and focused on the essential rather than on details without any bad conscience (Godfroy, Genin 2009).

Overall, family was rarely constructed by interviewees as an "impediment" to conducting research in STEM. Indeed, the picture of work and family life offered was less conflicted than it is often represented to be for professional women in general and academic women in particular (Armenti, 2004; O'Laughlin & Bischoff, 2005; Ceci, Williams 2014). Some women relied on family to do the "boundary work" they could no longer do for themselves. The "inflexible" or non-negotiable nature of family responsibilities— rather than being represented as conflicting with research commitments—was offered by several women as their only available "break" on otherwise relentless work demands (Ceci, Williams, 2014: 54).

The salient impact of WLB issue was already evident for physics graduate students. Similarly, Dabney and Tai (2013) illuminate the female physicists' experiences of conflict in achieving balance within their graduate school experiences and personal lives. The lack of balance/imbalance directly shapes the outlook of their future careers and possible career choices. Women individually reported that graduate school often causes feelings of guilt and that maintaining a life outside of graduate school can lead to a feeling of hindered progress. Being in a masculinist culture, women found themselves with inadequate peer social skills. In the end, the repeated need and search for balance in their lives engenders future careers choices, which concerned a perceived lack of time outside of school, lack of time for family, a need for support, and further reflection on the importance of a balance between one's life and their career. Some respondents have therefore already indicated that they would rather have a career more based on teaching or working for the government, in order to maintain a better work-life balance. According to Dabney and Tai (2013: 010115-7), "it is feelings like this that often contribute to the lack of females within tenured physics academic positions".

In fact, Desrochers, Hilton, and Larwood (2002) tested hypotheses related to three different perspectives of work/family conflict in predicting role strain among 100 business professors with preadolescent-aged children. As argued by O'Laughlin and Bischoff (2005: 82), they unveiled "partial support for the role strain perspective (time commitment to work predicted greater role strain), the role balance perspective (strong commitment to parenting identity, but not work identity, predicted lower levels of role strain), and the identity conflict perspective (time commitment to work predicted greater role strain for parents with high identity commitments to both work and parenting)". Regrettably, much research on academics and WLB remains anecdotal and, although parental status has not been found to be related to productivity (Cole & Zuckerman, 1987; Sax, Hagedorn, Arredondo, & DiCrisi, in press; Sonnert & Holton, 1996), research (e.g., Milkie & Peltola, 1999) suggests that the experience of balancing family and career may be very different for women versus men. Cole and Zuckerman (1987) found that women scientists were more likely to report giving up discretionary time and flexibility to balance family and job responsibilities. Duxbury and Higgins (1994) also found that working mothers spent less time in leisure activities than did fathers.

O'Laughlin and Bischoff's MANOVA project revealed a gender effect regarding work/family balance, work stress and levels of workplace support for family: women respondents had slightly elevated levels of both academic stress, and family stress. For women, available institutional support was insufficient (2005: 95). Looking at temporal division of household chores and workplace obligations, considerable time reported by women academicians was devoted to child care and household tasks ranged from 59% (cleaning) to 67% (laundry), whereas the average percentage of time reported by men academicians ranged from 27% (laundry) to 49% (cooking). According to O'Laughlin and Bischoff, satisfaction with day care was a significant predictor in alleviating family-related stress for men, yet not for women, pointing to the fact that men were more commonly relying on their non-academic female partner to contribute and organize care (ibid). Spousal support of one's academic endeavors was crucial for women but not for men (Grant et al. 2000).

Recently, some efforts have been made to expand the STEM research on WLB to cover relationships between men and women rather than solely female burdens (Damaske et al. 2014, see also Fox et al. 2011). By conducting in-depth interviews with men across different ranks in biology and physics at prestigious US universities, Damaske and colleagues created a four-pronged typology of academic science men, namely: forgoing children, egalitarian partners, neo-traditional dual-earners, and traditional breadwinners. The male scientists remain strong in terms of devotion to their work, but increasingly also hope for egalitarian relationships, which they nevertheless frame as reducing their devotion to work. The majority of men reported that the all-consuming nature of academic science starkly impedes their chances for adhering to the changing fatherhood norms. Increasingly, home life is not solely the concern of women, but is becoming a shared concern between women and men, and universities are often not structured to support men in this role (Lundquist et al., 2012; Damaske et al. 2014; Jacobs, Winslow 2004).

4. Scientists having children: a gender barrier impossible to alleviate?

Fertility – seen both as a biological process and as a lifestyle choice - has been continuously named a salient issue for women's lacking progress in physics and adjacent disciplines. Women who have become physicists report that one of the major obstacles in their path on the way was the expectation that they would also be the primary caregiver for their children (Ivie et al. 2001, 2002; Ivie, et.al. 2013; Ceci, Williams, 2009; Ward, Wolf-Wender 2004; Fox 2005; Whittington 2011).

In the global survey of physicists, women were more likely than men to say that becoming a parent significantly affected their work in various way by an almost two-to-one margin (Ivie, Tesfaye, 2012:49). This meant that women were likely to alter their schedules, spend less time at work, as well as become more efficient at their jobs. Those findings echo results from the first two IUPAP surveys, in which women physicists reported that having children forced them to complete their tasks quicker in order to leave laboratory or office in time to pick up young children from child care. The majority of employers have not been reported to accommodate a change to family's situation of a scientist, as the workloads remained unmodified. Still, women were found to be given less challenging work than men following having children.

AIP's analysis of the two earlier surveys showed that when women compared themselves with others who had completed their final degrees at about the same time, women with children were more likely to report relatively slow career progress. In the third survey, it was further made clear that women with children observed their careers progressing more slowly than those of their male and childless colleagues. Fathers noted no such effects. In sum, the results also show the dampening effect of having children on women's but not men's careers (Ivie, Tesfaye, 2012: 70). The results were applicable to physicists across the world, regardless of their age, employment sector, and their country's level of economic development (see also Wolfinger et al., 2012).

Ceci and Williams (2010) break this general claim down and state that there is a stark discrepancy in how having children early on in one's career exerts considerably more pressure on pre-tenure woman than men. What is more, it has been examined that men and women pursuing careers in academia delay parenthood until after securing their first stable academic position (Blinn & Ryan, 1990). This also holds for male faculty, who similarly delay childbearing until after tenure (Drago et al., 2006). What is crucial as well is that faculty working in the STEM fields take paternity and maternity leave at much lower rates than other academics (Lundquist et al., 2012), regardless of gender.

Authors also point to a systemic flaw in that the tenure system strongly discourages and disincentives women from childbearing and procreation. Mason and Goulden (2004) recall that there is an entanglement between cultural expectations surrounding care and academic women's career outcomes. More specifically, a belief which requires women to take most of the child care and household responsibilities, can be linked to the fact that scientists who are mothers are 29% less likely to enter tenure-track positions than women without children. It is these disincentives that ultimately explain why it is oftentimes women (and not men) in the academic research who remain childless (Ceci, Williams, 2010, Ecklund et al. 2011). In the global survey, more women, particularly those in senior positions, deliberately chose not to marry or not to have children so that they could focus on physics (Ivie, Tifaye, 2012:53). In the aforementioned study by Fox (2005), the predominant pattern of family composition for women scientists is that of ‘no children’, found among 52% of women (compared with 21% of men).

Interestingly, however, “the productivity of women with preschool children is higher than that of women without children or those with school-aged children. In pursuing factors that may be associated with this anomalous pattern, women scientists who have preschool children show signs of being a socially selective group in marriage and family patterns, research interests, and allocations of time” (see also Fox, 2005; Fox et al. 2011). As a consequence, there is no clear recommendation on if and how the support for boosting productivity for scientists-mothers should be promoted. At the same time, women who are full professors are much less likely to be married with children than men who are full professors (Mason Goulden 2004; see also Majcher 2008).

For Fox, the important shift in research on productivity and gender relates to accounting for variability beyond married/unmarried and childless/with children (2005: 145). More specifically, women in subsequent marriages have higher productivity than women in first marriages. This relates to their greater likelihood to be married to another scientist; and being married to a scientist apparently increases work satisfaction. Simultaneously, potential difficulties related to combining parenthood and academia may be lessened by personal factors such as spousal support and adequate child care arrangements (Mason, Gulden 2006). Valian (1998) discovered that women in full-time, tenure-track positions may be those who have found satisfactory child care, whereas women who have not found solutions may be in part-time or non-tenure-track positions.

“The baby penalty” in academia is further explored by Mason et al. (2013) and Wolfinger et al. (2010), as the authors attempt to matrix the features and complexities behind women in science being less likely to acquire stable positions when they have children. Once again, it is reiterated that both men (with or without children) and childless women have higher chances of success in academic career, which is seen as discouraging women from pursuing graduate degrees and becoming faculty members in the sciences. The authors include recommendations for addressing these inequalities such as entitlements, rather than special accommodations, like tenure-clock stoppage and parental leave, that are available to both men and women.

Women in science are generally aware of the “baby penalty” and Ecklund and colleagues found that, as a result, they are willing to forsake academic careers (2011). Female scientists at top universities not only have fewer children than their male colleagues but also are more likely to say that, due to the science career, they have fewer children than they want. Yet having fewer children than desired has a greater impact on men's life satisfaction. According to Ecklund et al, one in four female graduate student and one in five postdoctoral fellows is considering a career outside science altogether in order to fulfill procreation plans. What is more, those who stay are doing it with a caveat that they will have fewer children than desired, or, otherwise, they leave.

Having children is clearly a life-course-persistent phenomenon, as even the tenure-track women with children are twice as likely as men to say they had fewer children than originally desired (Mason, Goulden, 2009). In another study, having children was one factor associated with less engagement in mathematical and science careers for women but not for men (Xie, Schauman, 2003). Lewis and Humbert (2010) add that women who embarked on a science-career typically experience numerous “attrition points”, especially after the maternity leave and hardened re-entry, but also at mid-career, when women leave upon failing to achieve the career progression experienced by their male colleagues (Hewlett et al., 2008).

Similarly, in a study based on a survey and case-research with women holding posts at prestigious academic institutions, Probert (2005) revealed a group of women who are permanently stuck just below the glass-ceiling. The findings qualitatively confirmed quantitative surveys failing to provide evidence that discrimination or bias in appointments, promotions and workloads were significant enough to explain men's domination at the senior levels. Conversely, significant gender differences with respect to certain kinds of human capital (e.g. educational: the effect of a PhD-granting institution), yet mainly found a quite particular explanation for the failure of women to progress in the form of demographic challenges unaccounted for before. These encompassed high rates of separation and divorce, far higher general rates of partnering among men than women, as well as the impact of older children's needs. This perspective suggests that family issues do not cease to be important after the procreation is completed and children grew, but rather permeate the lives of female and male staff in academia in a profound and gender-differentiated manner (Probert, 2005).

Contradictory evidence of gender and parenting is somewhat provided by studies on academic and scientist fathers. Academic men also have fewer children than other professionals, such as physicians and attorneys (Wolfinger et al. 2010). Once they have children, fathers may be less likely than mothers to take advantage of work-family policies because of cultural expectations that such policies are meant for mothers rather than fathers (Lundquist et al 2012). While most studies find fewer work penalties for having children affecting fathers, other research suggests that this bias may be because, unlike mothers, academic fathers are expected not to take advantage of universities' work-family policies (Descombe et al. 2014; Drago et al., 2006). Having a child under the age of six significantly increases reported experiences of work-family conflict for scientist fathers (Fox, 2005; Fox et al., 2011).

In sum, the gender disproportion of "motherhood penalty" is two-fold: not only is it more common for male academic scientists to have children than for female scientists, but also men with children are more likely to be tenured than women with children (Ceci, Williams, 2010) Reiterating the importance of the gender/attrition matrix, newly matriculated PhDs applying for coveted jobs are less commonly women, and then, throughout all career steps, women are more likely to cease their career-track in academic research in STEM for family reasons. The above "leaky pipeline", as mentioned, persists across the life-course and professional path (Lewis, Humbert, 2010; Probert 2005).

5. Conclusions and Recommendations

- <u>Thinking about career pathways on a temporal axis should be adjusted to account for the process of family formation and raising children:</u>
    - Ceci and Williams (2009) review the strategies that women take to counter the fertility penalty and reflect upon a more <u>structural need for stopping the tenure clocks</u> for family formation. Moreover, it has been suggested that adjustments should be made to incorporate a possibility of smoothly continuing professional involvement on a <u>part-time basis</u>, as well as to allow for a later transition back to full-time posts (see also EC 2010).
    - Various Gender Equity Committees have further suggested that the length of times permitted for individuals for <u>early-career stages to work on and apply for grants should systematically accommodate family processes.</u> Moreover, the <u>funding and finance schemes must be sensitive and responsive to the needs of child-rearing</u>, for instance by including no-cost grant extensions, supplements to hire additional staff to maintain momentum during family leaves, as well as options to reduce research

and teaching responsibilities for women with newborns. Further, the funding mechanisms should enable grants for retooling after leaves of absence (Ceci, Williams, 2011)
- o More comparative and wide-scoped research is needed on the differing life-course issues within the scholarly careers of men and women, since it is possible that traditional timing of hiring, tenure, and promotion effectively denies society and science the contributions of talented women.
- o Future research must acknowledge that the majority of studies on female productivity and family reconciliation in academe are conducted among women who have survived a rigorous and demanding process of scrutiny, selection, and evaluation in science. This way, the sampling is biased and fails to recognize the family/gender/imbalance/inflexibility and temporal causes of leavers (Mason, Goulden 2004: 146). Research on those prone to attrition and those who left is necessary, ideally taking on a longitudinal perspective.

- An approach to family (and family policy) should be revised to include dual-career couples' logic and incorporation of men's family roles:
  - o Promotion of dual-career couples by co-hiring partners and/or spouses is recommended (Ceci, Williams 2011; Ceci et al. 2009; O'Laughlin, Bischoff 2005). A study of 276 couples in which at least one spouse worked for a university found that men whose wives worked at the same university reported greater family success and less spill-over of home/work stress realms (Sweet & Moen, 2002).
  - o Spousal support for career is an influence that must be addressed at a family level rather than institutional level (O'Laughlin, Bischoff 2005)
  - o Quality day care services and departmental support for balancing work/family demands are two factors that should be easily addressed by most institutions. Ideally, childcare provisions should be provided on-site by the workplace, thus being conducive to the nature of academic career (O'Laughlin, Bischoff 2005; Ecklund et al., 2011). Academic institutions could help to reduce work/family stress among faculty, thereby improving job performance, by ensuring the availability of quality day care services. Less is known about boosting academic productivity of women with children (Fox 2005).
  - o Including the perspective of men/fathers as integral to couples'/woman's success (Lundkvist et al. 2012; Damaske et al.2014). Scholars believe that academic men's desire to partake in family life have practical implications for the social reproduction of masculinity within academic science: the full professors who are more likely to be traditional men are also the ones who are the mentors and advisors to a younger cohort of neo-traditional and egalitarian men. Further, men in science need to receive trainings as they play key roles in hiring, retention, and promotion decisions. The authors suggest that "if science does not change to accommodate family life for both men and women, and if advisers do not adapt to accommodate changing notions of masculinity among young men in science, then the academic science pipeline may begin to leak young men as well as young women, increasing the overall loss of talent in academic science" (Damaske et al. 2014: 498).
  - o Mentoring programs—for both men and women—need to incorporate the matters of family life reconciliations and balance more explicitly (Ecklund 2011).
  - o Administrators must be provided with sensitivity training in work/family issues to increase both departmental and institutional support; faculty should make greater

use of the flexible nature of academic positions without guilt or fears over negative evaluation (O'Laughlin, Bischoff 2005).

- Individually selectable solutions around flexible work should be offered:
  - For Lewis and Humbert (2010), one strategy for countering attrition associated with the transition to and practice of motherhood, is the development of flexible working arrangements (FWAs) or work-life balance policies designed to enable women (and in principle at least, men) to combine career and family.
  - FWAs and autonomy in academia could be promoted, as agency over one's schedule was found elsewhere to increase a sense of control, reduce work/family stress, and improvement of life quality for mothers and fathers (Hill et al. 2013). However, looking beyond SET organizations, the authors argue that there is much evidence of a widespread implementation gap between well-meant and well-drafted policy and the execution of practices and powers in this respect (Lewis, 1997, 2001; Gambles et al., 2006; Damaske et al. 2014). In specifics, policies are often undermined by non-supportive managers (Lewis et al., 2009) and gendered workplace cultures (Haas and Hwang, 2007). Further, mechanisms may be counter-productive and unjust towards employees, as the forth-fifths week practice demonstrated (Lewis, Humbert, 2010).
  - Women reported support towards schemes enabling active researchers to "buy themselves out" of classroom teaching from time to time, but interestingly, several high profile researchers who were no longer required to spend very much time in the classroom did not necessarily see this as a benefit, either for themselves or for the students (Devin, Morrison, 2011: 52). Thus, it can be inferred that schemes of this kind should be allowed on the personal choice basis rather than unequivocally deployed to all female staff. Promotion of a "work-redesign model": a type of flexibility "purposefully developed by work organizations in response to the work-family challenges of employees, in which employees need not ask for "accommodations" for their work-family needs, but, instead, are afforded increased general autonomy and schedule control" (Damaske et al. 2014; Perlow, Kelly, 2014).

Examples of good practices:

KIT (Germany). The establishment of children's day care centres for employees with a total of 215 children's day care places for children between 3 months and school entry age. The KIT also offers emergency care to help in cases of temporary need for child care (http://www.familienportal.kit.edu/english/94.php).

Swiss National Science Foundation (Switzerland). Running a specific return program (Marie Heim-Vogtlin) aimed at female doctoral students and postdocs in Switzerland who had to interrupt or reduce their research activities due to family commitments. The grant includes the salary of the grantee for up to two years and, in addition, it can cover a portion of the research costs as well as childcare costs. It is possible to work part-time (http://www.snf.ch/en/funding/careers/mhv-grants/Pages/default.aspx#Statistics).

Joanneum Research (Austria). Implements an option called "Papa Weeks" – during the first three months of fatherhood, the brand-new fathers may request up to two weeks of paid leave. Since the introduction of this unique opportunity in 2010, it has been used by 45 fathers, 13 of whom also subsequently took paternity leave (https://www.joanneum.at/en/get-to-know-us/corporate-social-responsibility/peoplejr.html).

University of Warwick (United Kingdom). Warwick Conference Support Awards – staff can apply for contribution to child-care costs associated with conference attendance.

National University of Ireland, Galway (Ireland). It has a radical gender equality plan includes measures to fund support for women returning from maternity leave, which would allow their departments to "buy out" staff from teaching and free them to concentrate on re-establishing their research.

University of Cork (Ireland). As part of GENOVATE project and its survey results, a cross University working group on maternity/family leave was established. It has been tasked with developing a Code of Practice on Managing Maternity & Family Leave (for review by the reporting and monitoring mechanism proposed to be established within "Annual Strategic Plan 2015/16" in order to combat women being at the "sympathy of colleagues" when returning from maternity leaves).

University of Glasgow (United Kingdom). Maternity Leave Toolkit and forum which include steps to foster academic men's involvement in family life; Parent Buddy Network assists working parents at University in securing childcare through collective efforts.

Genomic Regulation Centre (Spain). The Gender Balance Committee of the Genomic Regulation Centre (CRG), functions at Spanish biomedical research institute of excellence since 2013. In 2014, the Committee initiated a mentoring programme geared towards young postdoctoral researchers, and, since 2015, it offers a support grant to CRG women scientists with family responsibilities which provides them with extra financial support (salary top-up of 400 € / month net, for one year). It is granted to excellent women scientists, hired at CRG as a PhD student or Post-doc, and mother of at least one child at the time of starting the grant. http://www.crg.eu/en/content/about-us-women-science/woss-women-scientists-support-grant

University of Luxemburg (Luxemburg). Convention to improve the reconciliation between family-life and research: The aim is to "enable full-time employees who are parents of young children (up to 4 years of age) working as researchers and teachers at the University of Luxembourg to optimise and reconcile child education and scientific activity in a manner complementary to the existing legal maternity leave and parental leave. As stated: "after the legal maternity leave (2-3 months), a full-time working parent may reduce his/her teaching activity to 20%." This applies to full-time teachers and researchers until the children commence pre-school. http://wwwen.uni.lu/content/download/63636/804188/file/Convention%20family_research%20UL.pdf.

5.1. New EIGE Toolbox of WLB Practices (2015)

Sparked by European Commission's Strategy for equality between women and men, The European Institute for Gender Equality (EIGE) commissioned a study on good WLB practices across the EU member states. Based on expert research of national data listing 93 good practices, 26 example ideas were initially identified and then narrowed to 13 by a range of stakeholders. The Good practices were collected under three thematic areas, as detailed further below:

1. Self-regulation;
   Employer-based or social partners-based self-regulation measures include:

- employer policies and initiatives designed to promote women's participation in the workforce
- issues around retaining working parents
- innovative forms of work organisation linked to reconciliation measures and flexible working time
- gender equality-oriented employer initiatives to promote men's involvement in parental leave and in sharing care responsibilities
- company-level agreements between the social partners and individually negotiated arrangements between workers and their managers to facilitate the reconciliation of work, family and private life.

2. Awareness-raising:
   Initiatives and campaigns to promote reconciliation of work, family and private life and are recognized to be the most effective means of communicating information, also to the general public. These include campaigns promoting:
   - increased women's access to and participation in the labour market
   - the wider involvement of men in care and family life
   - promoting changes in company culture through work organisation
   - flexible working hours and reconciliation of work, family and private life in public and private organizations.
3. Benchmarking:
   Understood as comparison of one organization's practices against those of others, aimed at identifying standards or good practices for better company performance. The initiatives/practices encompassed in the area of 'benchmarking in the field of reconciliation' span:
   - competition between companies/organisations for family-friendly or equal opportunity awards
   - certification of companies in relation to gender equality and family-friendly measures at the workplace
   - sustainability index to evaluate, rank and improve the performance of enterprises including gender equality and work–family balance criteria
   - gender equality audits; annual contests and awards that recognize outstanding practice in equality and diversity at work, etc (EIGE 2015).

Chapter IV Presence and Visibility

In this section the direct correlates of a disproportional underrepresentation of women among researcher and scientific staff are debated, which relates to the GENERA's Field of Action "Presence and visibility". More specifically, the analysis covers the issues of impediments to gender-balanced representation in science found in recruitment practices and advancement procedures, as well as gendered aspects of retention, attrition and visibility in physics and in science in general.

1. Gender bias in recruitment practices

Human resource processes may pose barriers to gender equality if they are vague, gender-neutral or gender-discriminatory. For example, it has been demonstrated that "women are more likely to succeed in recruitment and promotion when there is clarity about what is required, information about the opportunities freely available and clear criteria used in decision-making. These approaches also benefit men, making clear how organizations function and what their values are" (European Commission 2012a: 19). Similarly, women may be deterred from applying for a position "by gender-neutral or gender-discriminatory advertising and job descriptions or be screened out by male-dominated recruitment panels with no or little gender training" (UNDP 2014: 21). Therefore, recruitment policies, processes and mechanisms require careful consideration using a gender equality perspective.

As for physics this requires also understanding why there is more balanced gender representation in some of its subfields than in others. This was the case of radioactivity in the first half of the XX century in Europe (Götschel 2010), nowadays female physicists seem to be more visible in new branches of physical medicine, biological physics and physics education research (Hasse, Trentemøller 2011; Barthelemy, Van Dusen, Henderson 2015; McPhee 2016). To explain this phenomenon it is argued that women can easier pursue scientific career within "not yet rigidly gendered research structures" of emerging branches of physics, as compared with the more well-established subfields of physics (Götschel 2010: 47). At the same time though, it was also demonstrated that women more eagerly than men place themselves in interdisciplinary fields of useful physics, including research that provide opportunities to help others (Hasse, Trentemøller 2011; Barthelemy, Van Dusen, Henderson 2015). These arguments suggest that stronger representation of female scientists in some subfields of physics may be the results of the interplay between structural factors including patterns of recruitment and promotion and women's informed strategies for retention and advancement.

When comparing recruitment practices and employment behavior in Europe, it should be noticed that there are considerable differences, both at national level and between different types of research organizations. As far as the discrepancies between countries are concerned, it is argued, that employment behavior "is the interplay of gender culture, gender order and the behaviour of women within the framework of gender arrangements which influences this behaviour. Cross-national differences in the development of female labour force participation rate, and of the share of women working part-time, can be primarily explained by differences in the cultural traditions between countries. Culture itself does not immediately determine employment behaviour, however, its influence is mediated by the policies of institutions which may lag behind (or progress in front of) cultural change and can itself be contradictory" (Pfau-Effinger 1998: 164). This observation relates fully to the field of science, which is demonstrated in the next section of this paper with the discussion on the various types of scientific cultures in physics that roughly overlaps different European countries. However, the framework conditions for employment, including those regarding pay, differ not only between countries but also between research organizations, including public universities and public research institutes. Moreover, actors involved in negotiation of remuneration also differ according to academic positions (Lipinsky 2014; DG Research and Innovation 2014).

Among the arguments to act towards more balanced gender distribution in science and research there is an empirically-proven observation that mixed-gender groups outperform mono-gender teams (male-only or female-only). Psychologists argue that a group's collective intelligence – understood as the general ability of the group to perform a wide variety of tasks – is positively correlated with the proportion of females in the group (Woolley et al., 2010). A study on teams in global companies revealed that "the key levers and drivers for innovative processes are positively influenced by having a 50:50 proportions of men and women in teams. This clearly shows that equal gender representation can help to unlock the innovative potential of teams" (Lehman Brothers Centre for Women in Business 2007). Moreover, it has been observed that, for Germany, collaboration between women and men in mixed-gender teams slightly more often leads to interdisciplinary publications than it is in case of mono-gender teams, which may illustrate the idea that "the diversity in gender composition is associated with the integration of knowledge from different disciplines" (Elsevier, 2015: 23)[20].

There are various initiatives, programmes and mechanisms that employ recommendations on how to increase the likelihood of hiring and retaining female STEM scientists throughout Europe. For example outreach campaigns encouraging young girls' interest in STEM are well established and individual fellowships for female researchers and women associations in STEM disciplines are available from a variety of research founders. Moreover, in some places target or quota regulations have been introduced. They include a fixed quota system and a cascade model. Fixed quota refers to setting a target of a defined proportion of the unrepresented sex until defined point of time in an organization or its' particular bodies. Cascade model refers to a stepped model of targets in recruitment and promotion procedures. According to this model, "flexible rates are calculated for all relevant career levels depending on the respective discipline, starting with the level of scientific young talent. The target rate of a given career level is calculated by way of a complex formula, which includes the actual percentage at the preceding level"[21] (Id 2014).

It is also argued that the effects of gender bias in the recruitment process can be reduced through toning down elitist language in job advertisements, prior agreement of the search committees on the set of desired qualities of a successful candidate as well as blind reviews (Urry 2015, see also: Isaac et.al. 2009). Among other evidence-based recommendations to reduce bias in hiring settings there are such institutional interventions as: designing process to allow applicants to provide individuating evidence of job-relevant competency, visibly displaying research evidence that men and women are equivalently successful in male sex-typed roles, ensuring that women comprise at least 25% of an applicant pool, designing equity directives and antibias training so that raters do not feel coerced during evaluation, not asking about parenthood status in the application, encouraging raters to spend adequate time and

[20] However, the same study revealed that the higher the ratio of women among authors, the lower the citation impact of the publication (Elsevier 2015: 21).

[21] For example, Helmholtz Association's goal is to increase the percentage of women holding W2/W3 professorships to about 20% (from currently 11%) by the end of 2017 (Id 2014).

avoid cognitive distractions during evaluation, using structured rather than unstructured interviews, not using man-suffix in job titles (e.g., use “chair” or “chairperson” as opposed to “chairman”), implementing training workshops for personnel decision makers that include examples of common hiring biases and group problem solving for overcoming such biases, and encouraging raters to use an inclusion rather than an exclusion selection strategy in constructing a final list of applicants (Isaac et.al. 2009). However, while all these methods are conducive to increasing the numbers of female scientists, “there is no comprehensive overview available which shows to what extent incentive programmes to hire female researchers effectively diminish gender biases” (Lipinsky 2014: 13) and challenge the masculinity norm of fulltime availability and mobility (Rolin, Vainio 2011). It is argued that “success indicators (…) focus on stepping up women’s representation in senior academic positions, instead of assessing the outcomes of changes created at the institutional level” (Lipinsky 2014: 13).

2. Leaky pipeline or vanishing box: patterns of female scientists’ retention and attrition

It is a well-established observation that the attrition rate in science and engineering is considerably higher among women than men (Pell 1996; McGregor, Bazi 2001; Committee on ... 2006a; Hasse, Trentemøller 2008; Caprile, Vallès 2010; Sretenova 2010; Etzkowitz, Ranga 2011). As in other STEM disciplines, there is disproportionate outflow of women from careers in physics at every stage in the academic hierarchy in the European countries, which contributes to the glass ceiling phenomenon. However, the extent of the loss differs from country to country. It has been demonstrated that there are more female physicists in Southern Europe and Central and Eastern Europe than in Northern Europe, including “the countries which are known for a high degree of gender equality and women’s emancipation” (Hasse, Trentemøller 2008: 192). Therefore there is a necessity to not only explore the causes of female attrition at different junctures, but also understand why disproportions between men and women are stronger in some countries compared to others or why some physics environments are more high-ceilinged than others. It has been observed that “(…) statistical figures reveal a kind of paradox – on the one hand the proportion of female researchers in all Eastern countries (except the Czech Republic) is above the EU-27 average (30%); on the other hand the so-called ‘glass ceiling index’ (which measures the gap between the progress of men and women in science careers) is thicker in the Eastern countries and stands above that of the EU-15. (…) It means that the move of Eastern women researchers into higher position is more difficult in the majority of Eastern countries, in comparison with their female colleagues in the EU-15. We argue that the identified ‘good news’ for Eastern women academics, i.e. the visible positive trend towards the improvement of gender equality in HES and GOV R&D, does not originate from the adoption of new organizational culture in the respective scientific organizations (universities and research centers) and/or from implementation of gender equality policy in these sectors. Generally speaking, the above statistics are more likely to reflect the current economic situation in Eastern countries and the poor image of science and scientists in Eastern societies, rather than the emergence of a new organizational culture for gender equality in scientific research. Therefore the above statistical data should be interpreted as the interface between science and the economy. We assume that each time a profession becomes low-paid and unattractive, as a rule it tends to be feminized, and vice versa, working in a feminized labour sector might reduce the payment level in the sector itself” (Sretenova 2010: 5; see also: Linková et.al. 2008).

The under-representation of women in STEM careers is frequently described through a ‘leaky pipeline’ metaphor. It describes a loss of female talent at every critical transition within a linear progression through a series of staged roles in research performing organizations, mainly in academia (Etzkowitz, Ranga 2011). This pipeline has several leaks, beginning early at least in secondary school and continuing throughout the whole scientific career (Pell 1996, United Nations 2011; Dasgupta, Stout 2014). Some female students who express interest in science careers change their minds when applying to universities and select other areas of study. Others begin their higher education in a STEM program, but opt out before graduation or after graduating with a STEM degree when they select another field as a career. Average representation of women further drops at every career stage until seniority. One of the major leaks is the critical juncture to tenure-track professorship (Blickenstaff 2005; Bonetta 2010; Mavriplis et.al. 2010). While the numbers of female scientists have improved over the last 20-25 years, their under-representation in STEM persist (Blickenstaff 2005: 369-370; see also: Pell 1996; Etzkowitz, Ranga, 2011).

The pipeline metaphor is widely criticized. While it demonstrates that in case of gender inequality in science it is not enough to activate strategies to "fill the pipeline" (increase the pool of women in the existing science system, strengthen the supply side), because many women, once inside the pipeline, opt out (McGregor, Bazi 2001)[22], it is accused for oversimplifying the gender dynamics of scientific fields while presenting the fields as overly homogeneous (Alegria, Branch, 2015: 322), assuming the separation of academia and industry institutional spheres by strong institutional boundaries that perpetuate a static social structure of science and technology and paying insufficient attention to the mechanisms of transition across institutional spheres, as they are alternative options for women leaving academia (Etzkowitz, Ranga 2011: 133) and neglecting the impact of gender bias and institutional policies and structures on female-talent loss in science (Roos, Gatta 2009).

An alternative metaphor of "the Vanish Box phenomenon" has been coined. It is a metaphor for the transition from the upper levels of academic science to emerging science-related professions, like technology transfer. It refers "to the recoupment, rather than loss, of women scientists through their reinsertion into an alternative context in which their value may be realised, and possibly capitalized upon to an even greater extent than in the original context from which they were made redundant. Such women scientists find new ways of utilizing their scientific, technical and relational skills in new cross-border occupational areas that translate knowledge into other socio-economically valuable forms" (Etzkowitz, Ranga 2011: 133). They provide not only new career paths with high knowledge content and focus on the creation of new value for society through commercialization of scientific research, but also more favourable work conditions in comparison to academic science and industrial research. The "Vanish Box" transition implies a complex mix of linear and non-linear trajectories that women follow, instead of the more traditional linear career path that is commonplace among male scientists.

The "Vanish Box" model includes four operational phases of this transition:

1. Institutional and individual blockages that remove more women than men at consecutive milestones of science career,

2. Disappearance into a 'reserve army' of unemployed or underemployed women in science created through their marginalization and underutilization,

[22] It is the "pump-priming" hypothesis assuming that "upward mobility in professional hierarchies would occur naturally once entry was assured remained unrealized and reality contradicted expectation: women in science, engineering and technology (SET) careers are lost at every educational transition stage" (Etzkowitz, Ranga 2011: 132).

3. Emergence of a new occupation (e.g. technology transfer (TT) organizations, such as science parks and incubators that aim to close the gap between basic and applied knowledge through new research translation mechanisms)[23],

4. The reappearance of the 'disappeared' women from academic science in the new occupations (Etzkowitz, Ranga 2011).

The vanishing box metaphor, as well as results of a number of studies (Bennett 2011; Barthelemy, McCormick, Henderson 2015) suggest that it is better to understand women's trajectories in science as pathways rather than linear pipelines.

The pipeline metaphor is also challenged because it is argued that women's lack of access and mobility in academia is no longer simply a 'pipeline' issue, it's also the effect of unintentional biases[24] and outdated institutional policies and structures (Committee on … 2006a; Roos, Gatta 2009). Such subtle mechanisms – operating as "gender schemas" that work in similar ways for women and men and can function either positively, negatively, or neutrally – may be more difficult to dismantle than more overt exclusionary practices. Social psychologists demonstrate how "implicit beliefs—among both women and men—can hinder women's recruitment to, acceptance in, and mobility into academic positions, especially positions of power and authority" (Roos, Gatta 2009: 8). Therefore there is a need to understand "the reasons why women enter a career break or gap, what their challenges are while in the gap and what, if anything, they feel could change the reasons why they entered the gap or improve their possible reentry into their academic career path in their chosen STEM field" (Mavriplis et.al. 2010: 143; see also Hasse, Trentemøller 2008).

3. 'Push' and 'pull' factors of attrition from science

There is a variety of factors that push and pull individuals out of a workplace. Searching for better work-life balance associated with the need to raise children, accommodate spouses' careers, manage own health issues or care for elderly family members is believed to be an important 'pull' reason for women to leave workplace, including the academia (Hewlett, Luce 2005; Mavriplis et.al. 2010). The results of the UPGEM project demonstrated that in some European countries most female physicists leave their career as scientists when they become mothers (Hasse, Trentemøller 2008: 192)[25]. According to the results of the longitudinal study of astronomy and astrophysics graduate students in the USA, women are more likely than men to encounter the 'two-body problem', resulting in relocation for a spouse or partner. "This type of relocation affected the likelihood of working outside physics or astronomy in two ways: (1) by directly increasing the likelihood of working outside the field and (2) by indirectly increasing the likelihood of limiting career options for someone else, which itself had direct effects on working outside the field" (Ivie, White, Chu 2016: 9).

[23] The TT profession emerged in academia in response to recognition by universities that it was in their interest and the public interest to regulate the introduction into the market of discoveries made on campus to insure ethical manufacture (Etzkowitz, Ranga 2011).
[24] They are measured with the Implicit Association Test (IAT), which measures "actions or judgments under the control of automatically activated evaluations, without the performer's awareness of that causation.
[25] Ironically quitting or breaking scientific career after becoming a mother most often takes place in countries which are known for a high degree of gender equality and women's emancipation, including Denmark (Hasse, Trentemøller 2008).

Aside from being pulled into a career gap women are also pushed away by the features of the job or workplace (Hewlett, Luce 2005). Discontent with science, in particular advancement opportunities it offers, the way it is conducted, and social relations it creates can be an equally important determinant for women's exit from scientific careers as searching for better work-life balance (Mavriplis et.al. 2010: 142). Lack of positions, the short-term contracts and better possibilities of getting a permanent position outside academia were reported to be most frequent reasons given by European physicists – both male and female - for leaving (Hasse, Trentemøller 2008; European Commission 2012c). The study of astronomy and astrophysics graduate students in the USA revealed that "women tended to be less satisfied with their advisors, which increased the likelihood of changing advisors, which in turn increased the odds of working outside physics and astronomy. (…)" (Ivie, White, Chu 2016: 9). Last but not least, the effects of masculinist culture of physics, in which presence of women is seen as "an anomaly" (Fox Keller 2008) are frequently reported to be challenging to female scientists, by making them feel like imposters and disabling their sense of belonging to the field.

The abovementioned study of astronomy and strophysics graduate students demonstrated that women were more likely than men to exhibit the imposter/impostor syndrome, which directly affected their thoughts about leaving astronomy (Ivie, White, Chu 2016). The imposter syndrome has been identified among achieving individuals whose work requires intellectual work and is understood as "believing that one's accomplishments came about not through genuine ability, but as a result of having been lucky, having worked harder than others, or having manipulated other people's impressions"(Langford, Clance 1993: 495, see also Evie, Ephraim 2011; Ivie, White, Chu 2016). In other words, a person who feels like an imposter or an intellectual phony believes that she or he does not really belong in a field because of lack of true ability (Evie, Ephraim 2009). While the impostor syndrome is neither gender- nor profession- specific, it appears to be prevalent and intense among female academics and students (Clance, Imes 1978), including women in astronomy and astrophysics (Evie, Ephraim 2001, 2009; Ivie, White, Chu 2016). The impostor feelings are argued to be the effect of the impact of cultural factors, such as highly competitive academic climate (Academic Culture feeds …2005; Hutchins 2015), as well as gender stereotypes, including perception of creativity and brilliance which is commonly associated with males (Clance, Imes 1978; Leslie, Cimpian, Meyer, Freeland 2015; Dasgupta 2016; Pehe 2017)[26].

Another study on the linkage between sense of belonging and academic outcomes makes it clear that "academic success is not solely an individual process driven by differences in abilities and aptitude. Rather, academic success is also a social process influenced by the extent to which students feel a sense of belonging in their academic environment" (Lewis et.al. 2016: 5). The data confirm that on average, women are more likely to opt out than men because they do not feel as they fit and are accepted in STEM, including physics (Hasse, Trentemøller 2008; European Commission 2012c).

Women's sense of belonging to physics can be weakened in a several ways. For example, one of the studies revealed that allocation of projects was not always influenced by appropriate factors, since perceived physical strength was sometimes given as a reason for giving particular assignments to males" (Whitelegg et al. 2002). Similarly, the results of a statistical analysis of gender systematics in the time allocation process at European Southern Observatory revealed that proposals submitted by female scientists showed a significantly

[26] It was demonstrated that there is a negative correlation between the extent to which practitioners of a discipline believe that success depends on sheer brilliance and women's (as well as African Americans') representation in this field. Physics is among the disciplines, where the belief that raw, innate talent is the main requirement for success, is especially strong (Leslie, Cimpian, Meyer, Freeland 2015).

lower probability of being allocated time (Patat 2016). Likewise, the study of career paths of the former postdoctoral researchers on the Run II Dzero experiment based at the Fermi National Accelerator Laboratory near Chicago, showed that "the female researchers were on average significantly more productive compared to their male peers, yet were allocated only 1/3 the amount of conference presentations based on their productivity", which appeared to have significant negative impact on their academic career advancement (Towers 2008: 1). The results of interviews conducted with female graduate students additionally proved the existence of sexism and gender microaggression in the physics and astronomy cultures (Barthelemy, McCormick, Henderson 2016). While overt sexism was reported to happen rarely, experience of microaggression including sexual objectification, second-class citizenship treatment and assumption of inferiority, restrictive gender roles, and invisibility was frequent. Reported cases of microaggression and hostile sexism "resulted in ignoring these women's ideas, conveying a message of women as objects, and restricting access to laboratory equipment. These interactions fundamentally changed the relationship these women had to their fields. These women were not able to interact with physics or astronomy as full participants, but as people mediated by the role expectations and restrictions placed on them" (Barthelemy, McCormick, Henderson 2016: 11). Finally, work by Gonsalves demonstrated how female doctoral students in physics had to ensure that they were not 'girly' to be able to assume the characteristics of a 'physicist' (cit. after Barthelemy, McCormick, Henderson 2016). Thus, it is urged that "a reliable route to increased representation of women in physics is to narrow the gap between women's and men's perceptions of belonging and create inclusive environments that affirm women's belonging just as much as men's" (Lewis, et.al. 2016: 8, see also Barthelemy, McCormick, Henderson 2016) .

4. Gender pay gap and New Public Management

Gender pay gap is another issue concerning recruitment, retention and attrition of female scientists as well as their promotion. Acting towards its limiting is a necessary step towards gender equality in science and research. In this context it is argued that the gender pay gap in research needs to be revisited in light of new managerial practices, including introduction of flexible means of remuneration such as endowments, flexible bonuses and other benefits. These initiatives are part of a wider strategy called New Public Management (NPM), which is "intended to resolve the alleged inefficiency and excessive bureaucracy of public institutions by introducing a market logic in the non-mercantile public sector" (Caprile, Vallès 2010: 59; see also: Pritchard 2011)[27].

Revisiting gender pay gap in light of NPM means implementation of integrated and active policies to monitor and rectify pay gaps in the research sector (Lipinsky 2014). It is important to remember that "gender inequalities occur and are as flexible and evolving as research and innovation systems. Merit-rating in national research and innovation systems, as well as the impacts of economic developments relating to R&I activity (taxation, knowledge-based spin-offs, etc.), should always be carefully reviewed from a gender perspective to identify driving forces that widen gender gaps in innovative spheres of research. Dynamic environments therefore demand equally innovative and practically effective tools to overcome recurring and evolving gender imbalances" (Lipinsky 2014: 8).

[27] For the review of research on the impact of NPM on gender equality see: Caprile, Vallès 2010.

However, sex-disaggregated data on pay differences in research is difficult to retrieve from the available statistics. “The difficulty in access to reliable data has been reinforced in the last decade with the universities’ financial autonomies allowing academic establishments to become more competitive, flexible and market-oriented — and gender disaggregated reporting on institutional expenditure has not become standard procedure yet. This, in part, makes it hard to monitor institutional compliance with EU law on equal pay in the public research sector. The status of researchers working in universities and public research institutions in the ERA ranges from ‘civil servants’ (FR, HR, SL) to ‘private employees’ (LU). In most cases, public and social partners provide a framework in which autonomous institutions negotiate salary and pay bonuses. The payment of bonuses depending on research performance is an increasing trend” (Lipinsky 2014: 27).

While monitoring the gender pay gap is an institutional duty in Austria, Cyprus and in Finland, other countries opt for voluntary measures (Luxembourg, Norway, Spain, UK) or mandate advisory committees with monitoring tasks (Slovenia (‘most institutions’)). “In general terms, the gender gap needs to be revisited in light of new inequalities caused by managerial practices, such as autonomy in negotiating pays and offering bonuses and endowments” (Lipinsky 2014: 27-28).

In terms of academic culture and consequences, the evidence on the actual status and effects of remuneration is mixed. Beede et al. (2011) point to the fact that women in STEM jobs are generally privileged as they 33 percent more than women at comparable posts holding non-STEM jobs. The STEM premium, which relates to the overall high earnings of this group of professionals, was noted to be higher for women than men. As a result, in comparison to other sectors, the gender wage gap is smaller in STEM jobs than in non-STEM jobs. Conversely, focusing on the disciplinary markers, Ceci and Williams contested that women’s salaries are lower than men’s in physics and related fields, even when they work in the same sector for the same number of years (2010). This trend has been documented in longitudinal research and persisted despite the growing representation of women in physics and astronomy (Ivie, Ray 2005:21). In a survey of AIP, which collected data from more than 4000 working scientists, women made significantly less than men, even when the findings are controlled for sectorial and temporal variables (i.e. years since earning a degree). The estimated difference is equal to almost 5% of the base annual starting salary for men in academe, although the difference applies to all sectors.

On a similar note, Racusin et al. (2012) tested for gender bias in deciding on salary and experimentally proved that the faculty hiring committee selected a higher starting salary and offered more mentorship to the selected fake male applicants. Gender bias was found in both male and female staff. Ceci and Williams (2014), however, argued that recent evidence in sex discrimination in STEM is of small magnitude, and, in funding schemes, the bias could not be confirmed in recent data in some countries (Sandstrom, Hallsten 2008), while Wenneras and Wold found even a reverse trend when they reviewed outcomes of 280 funding applications from 2004 and indicated slight favour towards women. Similarly, women were responsive and positive towards the grant schemes that allowed for accounting for career breaks and recognizes that women can take maternity leave by adding the time taken out onto the fellowship at the end of the contract (Whitelegg et al. 2002).

It has to be reiterated, though, that postdoctoral positions funded by short-term research grants are the norm for several years after completion of the PhD and these years coincide with the optimum childbearing years for women (Whitelegg 2002). Interviewed female scientists therefore decided on delaying having children until their thirties, when they hoped to have permanent positions. At the same time, women still feared that there may be discrimination against women with children for hiring and recruitment pertinent to these positions.

5. Mobility and international collaboration

Mobility plays a crucial role in scientific development and career. Geographical mobility is essential for knowledge exchange processes and the relationship building (Ackers 2010), including establishing scientific collaboration (Uhly et.al. 2017). While it is not the only path to career advancement, geographical mobility is also "a common prerequisite for having access to tenured positions in some scientific fields, academic institutions or national contexts" (Caprile, Vallès 2010: 26). While "traditionally researcher mobility has been implicitly characterised as involving an extended period of residence abroad (often 2-3 years), usually implying a period of employment (or a scholarship) at doctoral/post-doctoral level" (Ackers 2010: n.p.), since recently mobility has been viewed as a continuum, covering also short-term stays at partner labs or at workshops and conferences (Ackers 2010).

The study on the views of the EU researchers on the factors that inhibit – mainly long-term – mobility revealed that much reference was made to 'quality of life' issues, including the necessity of dual income families, the difficulties in maintaining two careers and the problems encountered in moving families and partners. Other concerns emerged around the issues of pension, tax, pay and benefits, career progression and availability of posts (European Commission 2008b). Among them a lack of pension transfer system and suitable social security schemes were frequently discussed.

In this context it is worth to signal a trend towards the feminization of academic migration that was identified in Central and Eastern Europe. The ENWISE Report reveals that women scientists in Central and Eastern European countries and in the Baltic States, facing difficult economic situations, are inclined to accept jobs below their qualification and in general to work for lesser wages, which is rarely the case for their male counterparts. This flexibility of attitude towards the labour market in fact makes them prospective emigrants (Sretenova 2010). The very process of academic migration incorporates a ***gender dimension*** that has been highly neglected and under-researched in mainstream research on brain drain issues. It can be assumed that gender plays a crucial role at each stage of the academic migration process – at the stage of decision-making on emigration, at the stage of immigration to the receiving country and at the stage of possible return back to the home country (Sretenova 2010).

While there is some evidence that women are generally less internationally mobile than men (Elsevier 2017), a few studies reveal the correlation between a researcher's life stage and the level of his or her mobility. According to them, whether people are mobile or not, does not depend so much on their gender, their life stages is more important. The results of the UNITECH International Study demonstrate that at the beginning of their professional career both women and men are very mobile and flexible. Depending on different stages of life the mobility of both women and men decreases (Trübswetter et al. 2015; Schraudner n. d.). However, at least in the American context "(r)estrictions to mobility due to bringing up children have different timing for men and women. In the case of men they coincide with the middle years of their career, a period of relative stability whilst mobility constraints for women are especially acute during the early years, the time of career formation, when the lack of geographical mobility may be most detrimental to the scientists' future career" (Caprile, Vallès 2010: 26).

While mobility has been playing an important role in scientific development and careers for many years, the evolution of the European Research Area (ERA) and the European Area of Higher Education (EHEA) – including adopting the "European Charter for Researchers" and the "Code of Conduct for the Recruitment of Researchers" in 2005 – have together increased the emphasis on researcher mobility (Ackers 2010). It is emphasized that "the availability of scientific talent in the EU requires greater mobility of researchers, as well as greater movement between academia and industry" (European Commission 2012a: 39). Therefore, actions contributing to women's mobility in the scientific system are highly expected to be taken. They should include: wider availability of inter-sector mobility for both early stage and established researchers; gender sensitive advertising of vacancy positions and providing access to researchers' industry relevant expertise online; putting in place adequate evaluation criteria, and a fair and transparent career evaluation process; as well as gender aware, trained evaluators and researchers from both sectors in the evaluation committees (European Commission 2012a). Additionally, it is argued that the facilitation of mobility also requires assessing "the concept itself and the benefits of targeting forms of mobility that do not require the upheaval associated with longer term residential moves and employment changes" (Ackers 2010: n.p.)

On individual level international mobility significantly correlates with international research collaboration (Scellato, Franzoni, Stephan 2012; Uhly et.al. 2017). To understand gaps in international research collaboration, Uhly et.al. (2017) introduced the concept of 'glass fences' – gendered obstacles and barriers that keep women from this engagement. Calculating the data from an International Survey of the Academic Profession conducted in 2007 of 19 countries, they provided evidence that the practice of international collaboration in academia is gendered as women are significantly less likely than men to collaborate internationally. While the presence of children does not result in insurmountable glass fences for women in terms of their participation in international research collaboration, partner's employment status matters. Female faculty members with academic partners have greater odds of participation in international research collaboration, regardless of the presence of children, in comparison with women faculty members whose partners hold full-time positions in other domains. This finding may indicate that "academic partners understand the academic professional structure and its demands, and may therefore encourage the engagement of their partners in international work" (Uhly et.al. 2017: 773; se also Elsevier 2017).

6. Different paths of career development

In Europe regulations defining promotion requirements and procedures differ between universities and research institutes; they also differ in relation to academic status, in particular between professorial and non-professorial academic staff. In most cases universities themselves define those requirements and procedures, and responsibility for promotion lies either at central or at de-central level. While the central level refers to the head of the institution, rector, academic senate, council or board of the institution, decentralization means giving responsibility for promotion to 'heads of units in collaboration with the human resources department' or institutions in which the 'departments implement procedures'. (Lipinsky 2014).

In spite of differences in promotion requirements and procedures there is a general model for academic advancement in scientific disciplines. It "includes a preference for a lock-step career progression from undergraduate to graduate education, to a postdoctoral position and then to an academic position with continuous employment, (…) and large amounts of contact time especially in lab-based disciplines, accompanied by an expectation that one's career is "made" in one's 30s (…)" (Mavriplis 2010: 142). This model does not provide for "women's biological clocks, disproportionately penalizes them and contributes to their slow advancement. While many women persevere in the field choosing their own path, they more often than men may find themselves in a "career break" or "gap", understood as a time without the full-time employment necessary to lead toward progress in the chosen field or career" (Mavriplis 2010). As a consequence, "the time required for promotion for women is usually longer than for men of comparable achievement" (Pell 1996: 2847). While overt sexual discrimination has been reduced (Ceci, Williams 2010; Hughes 2014), slower promotion of female scientist can be assigned to inequitable access to resources, failure to network and receive appropriate recognition (Pell 1996; Ivie, Tesfaye 2012; Ivie et.al., 2013). However, while there is a recognition of a need to enhance advancement of female scientists, there is some resistance to women-only career development programmes and networks. A study on female engineers revealed that many of them opposed such programmes "for fear that this will create unwanted barriers with their men colleagues, or be seen as meaning women need help to get on. (...) This view clearly brings into question the competence of women engineers, and serves to further undermine their professional self-esteem" (Lee, Faulkner, Alemany 2010: 93-94).

Taking everything into consideration it can be suggested that successful career development programmes that would enhance gender equality should combine individual programmes to equip women scientists with the necessary soft skills to advance, such as networking (European Commission 2008a), mentoring, stipends, training, the provision of role models and programs that help them secure part-time work or create ana maintain social network for "gap" women, with incentives encouraging structural changes in research organizations through "increasing diversity in recruitment; introducing promotion and retention policies; updating management and research-assessment standards; developing course content to successfully attract women as well as men; policies for dual career couples; and schemes that allow women to return to work after career breaks" (Muhlenbruch, Jochimsen 2013: 41), including practices to sustain scientists during a career break, through reduced membership rates in professional societies and reduced conference fees for unemployed persons, as well as onsite child care at conferences (Mavriplis et. al. 2010). It is also argued that a common organisational response to resistance is either to make the policies available 'for all', or to persuade staff (and their managers) of the reasons why radical measures are needed (Lee, Faulkner, Alemany 2010: 94).

Paths to career development are closely linked how gender affects performance measurements. In this realm, mail survey of science faculty led Fox to address and challenge the issues surrounding academic publication productivity, which is a central process for science. She argues that it is "through publications that research findings are communicated and verified, and that scientific priority is established" (2005:131). Therefore, research must seek to understand factors that are associated with productivity, and variation in productivity by gender in order to "correct inequities in rewards, including rank, promotion, and salary". For Fox, this is because publication productivity operates as both cause and effect of one's status in science: it both reflects women's depressed rank and status, and partially accounts for it (ibid, see also Fox, Stephan 2001; Fox, Mohapatra 2007; Fox, Colatrella 2006). Moreover, comparable levels of publication produce neither the same assessment, nor the same rewards for women and men (Sonnert & Holton, 1995; Nosek et al. 2002; Moss-Racusin et al. 2012; Hill et al. 2010; Sheltzer and Smith 2009; Ecklund et al. 2012).

Dever and Morrison (2011) establish that university research work is marked by increasing attention to performance indicators (Bruneau & Savage, 2002; Morley 2003; Ramsden, 1999) for academic staff (including, e.g., the auditing of publications and grant income) and by the implementation of research quality assessment exercises in a number of countries (French, Massy, & Young, 2001; Harley, 2003; Mace, 2000). Considerable work has gone into investigating the impediments to women's full participation in research and a range of contributing factors have been identified, but investigating the conditions that support high research performance in women were less prevalent (Dever, Morrison 2011).

Studies pointed to the benefits arising from structured programmes focusing on building women's research capacities, as well as certain forms of formal and informal mentoring (Groombridge & Worden, 2003; Higgs, 2003). It has been specified further that women oftentimes perceived assistance and mentoring as "a privilege" than as a right, a perception that impeded women in physics from fully benefitting from this relationship as early-career researchers (Whitelegg et al.2002). Women, conversely, had a tendency to link mentorship with passionate interest in a research topic and congenial methodology to the effect of an improved research productivity for women (Gallos, 1996; King, 1996). On mentorship, both Ecklund et al (2011) and Dabney and Tai (2013) underscore the expansion of mentorship curricula to work/family life issues, which remain the most problem-generating for women in physics. Persistence in the field is conditioned upon the plethora of support, including departmental assistance, advisers, mentors, peers, and women's support groups.

One persistently difficult to address area is the measurement of countable indicators of male vis-à-vis female performance. For instance, Jagsi et al. (2006) sought to analyze gender gap in medical literature authorship and calculated original articles from six prominent medical journals over the past four decades to explore the disparities among men and women in academic medical publishing. Although the proportion of women authors of original research has increased, women still compose a minority of the authors of original research and guest editorials. Likewise, an analysis of a complete sample of over 200,000 publications from 1950 to 2015 from five major astronomy journals demonstrated that while fraction of papers which have a female first author has increased from less than 5% to about 25%, this rise is slowest in the most prestigious journals. At the same time, papers with male first authors continue to receive more citations than papers with female first authors, however this gap has been decreasing with time (Caplar, Tacchella, Birrer 2016). In effect, this type of "improvement"-hailing is typical, yet it rarely addresses the root causes of the continued imbalance, instead praising a victory. Furthermore, indicators like number of publications are inherent to parametric systems of performance assessment, yet they have also been highly contested over the years.

Finally, in the review by Lincoln and colleagues (2012), awards and prizes are analysed as performance indicators, which depict stratification of science and unequal distributions in rewarding processes. Trajectories shaped by awards are pivotally exhibited by those already boasting good reputation, which is demonstrative of the Matthew Effect. This, in turn, is tied to a great deal of evidence about lacking meritocracy and the fact that scientific efforts and achievements of women do not receive the same recognition as do those of men, namely due to the Matilda Effect. According to Lincoln et al (2012), "awards in science, technology, engineering and medical (STEM) fields are not immune to these biases (…) while women's receipt of professional awards and prizes has increased in the past two decades, men continue to win a higher proportion of awards for scholarly research than expected based on their representation in the nomination pool". The effects, which the researchers call "powerful twin influences of implicit bias and committee chairs, illuminate the relationship of external social factors to women's science careers. Further, the researchers challenge the ghettoization of women's accomplishments into a category of 'women-only' awards.

In sum, Fox highlights the ideological and practical incompatibilities by stating that the mythology of science (Bruer, 1984) has it that good scientists are either men with wives, or women without husbands and children (Fox, 2005). This conventional wisdom has been challenged, as studies indicated that married women publish as much as or more than unmarried women (Cole & Zuckerman, 1987). Similarly, there is no consensus on the presence of children having effect on women's productivity, ranging from no effect (Cole & Zuckerman, 1987), a slightly negative, non-significant effect (Reskin, 1978; Long, 1990), or a positive effect (Astin & Davis, 1985; Fox & Faver, 1985). For Fox, these patterns remain puzzling and somewhat counter-intuitive (2005, see also Whittington 2011).

7. Tokenism and non-events

Making female scientists visible inside and outside of the research organization has various purposes. It not only informs wider public on women's presence and achievements in science and, therefore, enables to challenge gender stereotypes, but also "allows for students and staff to see a number of possibilities in achievement and to choose from a variety of role models" and "encourages women already present in scientific institutions to reach higher positions" (European Commission 2012a: 31; see also Rees 2001; European Commission 2008a). Therefore it is recommended that "all public relations activities from scientific institutions should be gender-proofed (represent women appropriately), while avoiding tokenism" (European Commission 2012a: 31). Gender proofing would mean including women in all promotional campaigns for scientific careers, nominating women for prizes, and recognizing their achievements appropriately.

The problem of tokenism needs further elaboration. It has been demonstrated that tokenism occurs in skewed work groups where the representatives of a minority group find themselves in the position of the very few among the very many and represent less than 15%. They are referred to as 'tokens' (representatives of their category rather than independent individuals), which "accounts for many of the difficulties such numerically scarce people face in fitting in, gaining peer acceptance, and behaving 'naturally'. The existence of tokens encourages social segregation and stereotyping (…)" (Kanter 1993: 6). Being a token means standing out compared to dominant group members, being under the constant scrutiny, exclusion from communication networks and entrapment in organizational roles that are deemed fitting or appropriate according to stereotypical assumptions. This exacts psychic costs, which may lead the individuals in the position of a token to overcompensate through either making themselves and their achievements invisible, or overachieving, or turning against people of his or her own kind (Kanter 1993: 6). Combined with negative stereotypes, tokenism may also lead women to experience identity threat, understood as appraising "the demands imposed by a stigma-relevant stressor as potentially harmful to his or her social identity, and as exceeding his or her resources to cope with those demands'" (cit. after Hirshfield 2010: 16). It is argued that "identity threat may then lead to gender segregation within STEM departments, which reproduces negative stereotypes about women in science and may explain their overrepresentation in lower-prestige subfields within their disciplines (Hirshfield 2010: 6-7). Tokenism refers to women in male-dominated fields, but may apply to men in female-dominated fields and can be extended to the experiences of racial/ethnic minorities (Kanter 1993; Shachar 2000; Stroshine and Brandl 2011)[28].

In the context of visibility of female scientists within and outside of the organization it has been argued that women pursuing career in science are affected not only by things that happen to them (e.g. discrimination), but also by 'non-events'. "Non-events are about not being seen, heard, supported, encouraged, taken into account, validated, invited, included, welcomed, greeted or simply asked along[29]. They are a powerful way to subtly discourage, sideline or exclude women from science. A single non-event — for example, failing to cite a relevant report from a female colleague — might seem almost harmless. But the accumulation of such slights over time can have a deep impact. Non-events can be manifold. Superiors or colleagues might ignore or bypass women's research and performance; fail to invite or welcome them to important informal and formal networks; bypass them for awards, prizes or invitations; fail to give them merit advancing tasks such as representing the research group in public forums; not ask them to design or participate in scientific meetings, conferences, panels or as keynote speakers; or simply stay silent when it comes to career support, advice and mentoring. Even supposedly small non-events can send a powerful message, such as when a female postdoc publishes a high-profile article that generates no reaction from senior local colleagues, while her male counterpart's parallel article is celebrated with high-fives all round. Non-events are challenging to recognize and often difficult to respond to. Nothing happened, so why the fuss? Often, nonevents are perceived only in hindsight or when comparing experiences with peers" (Scientists of the World 2013: 38; see also Caprile, Vallès, 2010: 33). Hence, it is believed that "learning to recognize various non-events would help women scientists to respond to them, individually or collectively, with confidence and without embarrassment" (Scientists of the World 2013: 38). Anonymous pooling of non-event experiences, monitoring the practices of support, encouragement, inclusion and exclusion in research groups, projects, networks, conferences and science institutions from a gender perspective, addressing the issue of no-events in management, supervisor training and early-career coaching are considered to be necessary tools for change (Scientists of the World 2013: 38).

8. A role model, a mentor and a queen bee

It has been argued that women's choices of careers in science are heavily influenced by role model relationships and both genders have been shown to benefit from identifying with successful examples in various fields (Bonetta, 2010; European Commission 2012a; Kelly 2016). However, the persistent problem is that there is, statistically speaking, a limited pool of female top-level physicists able to serve as role-models. Ivie and Ray (2005:9) specify that not only are the percentages of physics degrees earned by women very low, the percentages of physics teachers and faculty who are women are even lower. In early 2000s, just 29% of high school physics teachers were women (Neuschatz and McFarling 2003), while the ratios drop

[28] In this context the fact that biographies and media representations of female scientists perpetuate gender stereotypes is very informative. Female scientists are often portrayed in their private roles as wives and mothers, the focus is on their appearance rather than their expertise and their scientific interests are framed as unusual (Shachar 2000; Chimba and Kitzinger 2010; Fara 2013).

[29] Non-events can also be seen as a category of microaggression, discussed above (see: 3. 'Push' and 'pull' factors of attrition from science).

even lower at later levels, with women scientists serving as faculty at degree-granting university and college departments staggered at 10% during that period (Ivie et al. 2003).

The presence of more women in the workplace or laboratory was generally felt to reduce the male atmosphere, but a contrary view was also given that sometimes it could be a good thing to be in a minority as it increased visibility and this may be to women's benefit (Whitelegg et al. 2002). In this study, "good role models were felt to be women who managed to combine their working and family lives efficiently and were felt by the interviewees to be more effective during the time they spent in the lab than some men who worked very long hours". Early-career women suggested that senior female role models with success and interest outside the lab/academia, tended to think about creative solutions to problems, unlike men who were viewed in a stereotypical manner of being fully devoted to science only (see also Whitten et al. 2004)[30].

Mentoring as an initiative for enhancing gender equality is also widely discussed. It is argued that mentoring programs in academia can ease adaptation of new faculty (and graduate students) who are unfamiliar with the dominant culture of the department and protect them from failures in scientific careers caused by incomprehension of rules (Pell 1996: 2847; O'Laughlin, Bischoff 2005). Similarly, "a dearth of guidance and mentorship early on" was recognized as the main reason for the lack of female physicists in American science (Scientists of the world speak up for equality, 2013: 37). It has also been found that if male and female astronomy students are mentored, they are less likely to feel like imposters, to have difficulty internally recognizing their own achievements (Ivie, Ephraim 2011).

However, even if mentors are available and they support female scientists in their careers, they often promote women less decidedly than their male colleagues. On the basis of the analysis of recommendation letters submitted by researchers from all world regions it has been revealed that female applicants were significantly less likely than their male counterparts to receive from their mentors – both men and women - 'excellent' letters of recommendation for postdoctoral positions in the earth sciences (Dutt et. al. 2016; Skibba 2016). Similar results came from the fields of chemistry, medicine, and psychology (Trix & Psenka 2003; Skibba 2016). Addressing the problem of hidden biases in letters of recommendation – as well as in the review of curricula vitae of applicants to scientific positions – is vital as application to faculty position has been identified as one of "the key non-structural bottlenecks restricting female participation in academia" (Shaw, Stanton 2012: 3736)[31]. Career transition from post-doctoral researcher to the professoriate has been widely identified as difficult for female scientists (Ceci et. al. 2014; Martinez et. al., 2007; Shaw, Stanton 2012). While family considerations seems to be one of the main factors that deter women from pursuing scientific career at this stage (Martinez et. al., 2007), gender bias in evaluation, hiring and promotion are argued to be of equal importance in the explanation of gender inequality in science and research, including physics (Urry 2015).

In this context the 'queen bee' syndrome is discussed. Is it so that women who "have attained senior positions do not use their power to assist struggling young women or to change the system that they have struggled through", tacitly validating it (Pugel 1997: no pages; see also: Młodożeniec, Knapińska 2013: 60). Studies do not provide the conclusive answer to this question. A few surveys of American workers demonstrated that women who achieved success in male-dominated environments were at times likely to oppose advancement of other

[30] The issue of role models in science and academia is further developed in the next section of this paper.
[31] Similarly, transition from undergraduate to graduate studies is argued to be critical for women (Shaw, Stanton 2012).

women, using various mechanisms including bulling (Drexler 2013). However, studies conducted for over 20 years in top management teams at 1500 American companies found that a female chief executive was more likely to appoint women in senior positions (Knapton 2015). However, studies on queen bee syndrome in science and outside the US context are lacking.

Another remark in this area is that, according to Barthelemy, Van Dusen, Henderson (2015), subfields within STEM vary significantly regarding the underrepresentation of women. While women in physics continue to be few and far between, the subfield of physics education research (PER) has a higher representation of women than physics as a whole. More specifically, an online survey to assess PER graduates' demographics, trajectory, climate experiences, and goals for their research revealed that women in PER experience similarly positive working relationships with faculty and fellow students. Last, both men and women reported building a stronger scientific workforce and becoming better teachers as goals for their PER research.

9. Networking as an instrument to empower female scientists

At the same time it has been recognized that formal and informal networking is important to boost career progression opportunities. It is argued that 'old boys networks' are still an obstacle to career progression in various fields. "In addition to gender bias that is common in these networks, many women are not able to network informally during and after work because of social norms, family obligations and other considerations" (UNDP 2014: 42). It has been observed that "missing out on opportunities to network and build social capital has especially negative consequences for middle and senior women managers and is partly responsible for the construction of the so-called 'glass ceiling', . Many work-related social activities do not formally exclude women, but because of broader gendered social divisions in society, women can feel less comfortable in such settings or have less time to participate. These out-of-work events, however, are vital for access to information and afford opportunities to form strategic alliances, both of which are essential for managers and professionals" (UNDP 2014: 24).

Benefits from networking are equally evident in science. Networking is necessary for acquiring information on time, for cooperation in research projects, for securing funding for research projects, for recruiting qualified staff members, for developing an academic career and for enhancing women's' influence in implementing their ideas" (Sagebiel 2014: 99-100). Moreover, networks of women scientists have been identified as key players in the research policy process, not only for being instrumental in the empowerment of women scientists, but also in the efforts to increase the number of women scientists in top positions (Williams, Diaz, Gebbie, El-Sayed 2005), and to make the voice of women scientists heard in the policy debate on a national, regional and international level (cit. after European Commission 2008a: 35)

10. Recommendations and good practices

This subsection summarizes main recommendations how to attain and sustain greater presence and visibility of female researchers. Where possible, examples of good practices utilizing these recommendations are added.

According to the results of literature review, greater **presence and visibility of female researchers may be achieved and sustained through**:

- clarity and transparency of hiring criteria, job requirements (European Commission 2012a; Urry 2015)
- blind reviews (Urry 2015)
- toning down elitist language in job advertisements and avoiding gender-neutral or gender-discriminatory advertising and job descriptions (UNDP 2014; Urry 2015)
- supporting the development of emerging branches of physics and interdisciplinary fields of useful physics (Götschel 2010, Hasse, Trentemøller 2011; Barthelemy, Van Dusen, Henderson 2015)
- introducing target or quota regulations including a fixed quota system and a cascade model (Id 2014)
- comprehensive overviewing "to what extent incentive programmes to hire female researchers effectively diminish gender biases" (Lipinsky 2014: 13)
- acknowledging that female-talent loss takes place at every career stage (McGregor, Bazi 2001, Etzkowitz, Ranga, 2011) and it is not enough to fill in the pipeline
- understanding women's trajectories in science as pathways rather than linear pipelines (Bennett 2011; Barthelemy, McCormick, Henderson 2015) "The linear career path of the modal male scientist of the past may not be the only route to success, and departments and universities should be encouraged and funded to experiment with alternate life course options. A partnership between the academy and funding agencies could be instrumental in researching such alternatives" (Ceci, Williams, 2011: 3162)
- recognizing that the dominant model for academic advancement in scientific disciplines does not provide for "women's biological clocks, disproportionately penalizes them and contributes to their slow advancement" (Mavriplis 2010)
- implementation of integrated and active policies to monitor and rectify pay gaps in the research sector (Lipinsky 2014)
- acknowledgment and dealing with career breaks is equally about: 1. addressing women's needs such as searching for better work-life balance associated with the need to raise children, accommodate spouses' careers or care for elderly family members; and 2. addressing the STEM culture including the way science is conducted, social relations it creates, and advancement opportunities it offers (Hasse, Trentemøller 2008; Mavriplis 2010; European Commission 2012c; Ivie, White, Chu 2016)
- acknowledgement that successful career development programmes should combine individual programmes to equip women scientists with the necessary soft skills to advance, such as networking (European Commission 2008a), mentoring, stipends, training and the provision of role models with incentives encouraging structural changes in research organizations through "increasing diversity in recruitment; introducing promotion and retention policies; updating management and research-assessment standards; developing course content to successfully attract women as well as men; policies for dual career couples; and schemes that allow women to return to work after career breaks" (Muhlenbruch, Jochimsen 2013: 41)

- learning to recognize various non-events through anonymous pooling of non-event experiences, monitoring the practices of support, encouragement, inclusion and exclusion in research groups, projects, networks, conferences and science institutions from a gender perspective, addressing the issue of no-events in management, supervisor training and early-career coaching are considered to be necessary tools for change (Scientists of the World 2013: 38). This applies as well to awards in science (Lincoln et al 2012).

Examples of good practices:

CNRS (France). Aimed at developing outreach actions to attract more women in STEM fields (a communication kit, featuring videos of women physicists working in CNRS labs, was conceived as a tool for interventions in high schools; partnering with the "*Femmes et mathématiques*" national association to further develop the annual "*Forum des jeunes mathématicien-ne-s*", which targets female PhD and Masters Students in mathematics) (Pépin et.al 2014).

National University of Ireland Galway (Ireland). Radical gender equality plan with quotas was implemented after research found discrimination and unconscious bias as key reasons behind low proportions of women in leadership positions.

Imperial College London (United Kingdom). Deploys an Academic Gender Strategy Committee: the diverse member-body of this committee includes the Chair of the Athena Committee, which in turn ensures changes in practices and culture at the departmental level to win or retain Athena SWAN awards. Representatives from award-holidng entities take part in regular bi-weekly progress meetings.

University of Nottingham (United Kingdom). The teams implementing Athena Swan charter's awards conduct self-assessment in order to monitor progress. This is a type of visible networking of prestigious award holders that can serve as role models.

University of Cambridge (United Kingdom). CV mentoring scheme initially in STEM, then expanded to non-STEM schools. Assistance with career-building and preparing job application documents from senior staff.

University of Edinburgh (United Kingdom). "There has been a progressive increase in the proportion of women appointed in our flagship "Chancellor's Fellows" scheme from 2012 to 2014 in response to strategies to make the advertisement more appealing to women, by using female role models and alternative media for advertisements. We will conduct a gender audit of all future large recruitment campaigns to inform improvements (AS 2015 Action 2.3 (iv))".

CNRS (France). It is organizing professional development trainings on careers for young women researchers and professors, which had strong impact at the Institut Néel target laboratory in particular, and helped create a women researchers' network. First steps have also been taken in developing a CNRS women researcher's database, which could be used by conference/event/award organizers and the media (Pépin et.al. 2014).

Helmholtz Association (Germany). The mentoring program aims at individual career development. An experienced executive (the mentor) passes on his or her knowledge and experience to a younger junior employee. At the same time, the mentor supports the mentee in her personal development and integration into networks. The MDC internal mentoring program for female postdocs aims at helping them to recognize and use their own potential, to increase their competences and make their decisions for the next steps in their careers (https://insights.mdc-berlin.de/en/2014/08/joined-for-a-time/).

Uppsala University Department of Physics and Astronomy (Sweden). It incorporates several components:

1. Goal: making the physical workplace less male dominated. Background: a space at the department was filled with pictures of male professors and scientists. Tools: it was suggested that new lecture halls could be named after female scientists. A number of pictures of male professors should be kept to a minimum (instead of them there should be more object-related pictures)
2. Goal: at least one teacher of one gender for the courses with more than one teacher (to build a presence of role models for female students). Tools: engaging female researchers to be tutors in the laboratory classes as well as inviting guest lectures to teach courses with only one teacher
3. Encouraging young female researchers to stay at the university after their first Post-doc position by establishing an efficient grant programme, in which the biggest portion goes to young female researchers. The programme supports as well female guest researchers' stay at the department. The gender equality grants programme is evaluated (Gender Equality Plan 2014-2016, 2014, http://www.physics.uu.se/digitalAssets/577/c_577016-l_3-k_ifa_equalityplan_2014-2016.pdf).

Umeå University (Sweden). It deploys:

- special funds to recruit female professors from other countries or to support senior female researchers aiming to be professors (Status Report: Women in Physics in Sweden 2011)
- network for all women with PhDs (KVINT) which works as a platform for support, inspiration, planning and information (Status Report: Women in Physics in Sweden 2011, http://www.norwip.org/files/otherfiles/0000/0028/SwedenStatus_report.pdf).

Seadrop Prize (Tengercsepp Díj, Hungary). It is given at the Faculty of Natural Sciences at the Eszterházy Károly College (in Eger Hungary) since 2010. This prize is awarded to female professors who have furthered the good reputation of the University by demonstrating at least one of the following achievements at an exceptionally high level: 1) excellence in teaching; 2) well-acknowledged professional results; 3) has helped the professional development of young talents; 4) has developed (funded) projects that supported the positive future of the Faculty; or 5) has participated in innovation of national or international reputation.

DFG (Germany). Research-oriented Standards on Gender Equality introduced by the German Research Foundation (DFG) – Germany's largest research-founding organization, the self-governing organization for science and research in Germany. It serves all branches of science and the humanities. The DFG is an association under private law. Its membership consists of German research universities, non-university research institutions, scientific associations and the Academies of Science and the Humanities. One of the elements of the standards is the 'cascade model', which implies that the institutions define targets for the proportion of women at each qualification level that must be higher than the proportion of women at the level below (Mühlenbruch, Jochimsen 2013; Lipinsky 2014; Zippel, Ferree, Zimmermann, 2016; http://www.dfg.de/en/research_funding/principles_dfg_funding/equal_opportunities/research_oriented/index.html; http://eige.europa.eu/gender-mainstreaming/tools-methods/gear/legislative-policy-backgrounds/germany).

Excellentia Program (Austria). Excellentia Program increased the percentage of female full professors at Austrian universities from 13% (in 2005) to 18% in 2010 offers additional funds for universities hiring female professors (Ritsch-Marte, Durstberger-Rennhofer 2009).

AMIT (Spain). Association of women scientists and women in technology http://www.amit-es.org The aims of the association are to promote gender equality in access to research positions, raise awareness about the issue of discrimination, make visible the success of women-scientists and women-researchers. It works to achieve full participation of women in research, science and technology.

The CERCA Institute (Spain). At the CERCA Institute (http://cerca.cat/en/women-in-science/), in 2013 the Equal Opportunities and Diversity Management Committee has been established. The committee was set up in order to fight gender bias in recruitment has decided to create a diversity commission to: "discuss and propose tools and measures to remove such bias and obstacles and to prevent waste of such highly qualified human capital, along with an equality plan to provide a model for research centres. The CERCA centres' diversity commission has drawn up a pioneering protocol to inform faculty, both men and women, that make up evaluation panels of the scientific data and theories that show bias in evaluation, which is particularly detrimental to women and which leads them to see evaluation as something hostile." http://cerca.cat/en/women-in-science/bias-in-recruitment/ The video about bias in recruitment: http://cerca.cat/en/women-in-science/bias-in-recruitment.

Universidad Politécnica de Madrid/Technical University of Madrid (Spain). To raise visibility of excellent women scientists, each year a nomination of a women for the Doctorate Honoris Causa is put forward. http://triggerproject.eu/wp-content/uploads/2014/05/Newsletter-3-_def.pdf (page 7)

AMONET (Portugal). Portuguese association of women in science AMONET http://www.amonet.pt/. "The Portuguese Women in Science Map is a project from AMONET. The historical interactive map contains information about Portuguese women that made a significant contribution to the advance of her main field of research and science in general. The digital map in divided in 12 main scientific areas: Architecture, Medicine, Chemistry, Physics, Biology, Engineering, Mathematics, Informatics, Geology, Meteorology, Law, and Human and Social Sciences."

Delft University of Technology (the Netherlands). At Delft, in order to increase the number of female faculty members offers high-profile, tenure-track positions to top female scientists in diverse research fields. The 5-year Fellowships are awarded to outstanding female scientists from any country and from any of the existing disciplines in the university, who are currently not employed by Delft University of Technology. The researchers establish their own research programme, receiving generous funding. After five years, if successful, the tenure is awarded and the researcher continues working at the institution. http://www.tudelft.nl/en/about-tu-delft/working-at-tu-delft/tu-delft-as-employer/delft-technology-fellowship/

FOM (the Netherlands). Funding programme for female physicists: provides postdoc positions or bridge the gap to a regular position (started 1999). On average two to four female scientists per year are funded. This tool is highly effective as many female scientists could improve their careers, e.g. got an assistant professor position or professorship later on. One of the FOM board members was funded by this tool.

Radboud University (the Netherlands). A mentoring programme for women academic and administrative staff: "The programme organises mentor groups for talented scientists to gain more insight into their current work position and what activities and skills are necessary for them to grow. (…) Evaluation of the programme has shown that the mobility of scientists can be improved by mentoring, e.g. many received important grants and improved their position. The aim of the programme is to provide practical support and advice for women talents (particularly post-docs, assistant and associate professors), who want to develop their academic careers. (…) On average, mentees have five to six meetings with their mentor per trajectory, which maximally takes up to one year. In addition to the mentoring programme, a career coach can be contacted within the Human Resources department." http://eige.europa.eu/gender-mainstreaming/tools-methods/GEAR/examples/stimulating-personal-developmentc.

Chapter V: Gender in Research and Education as a lens into gender-inclusive organizational cultures

In this section, another branch of literature concerned with how women in physics, and female scientists in general, are portrayed within the organizational culture, as well as how various dimensions of scientific research impede or strengthen women's chances of success in STEM. Again referring to the GENERA's Field of Action, the literature examined here deals with "Gender-inclusive/Gender-sensitive Organizational Culture and Gender Dimension in Research and Education". The reason behind this approach is that subfields in these two themes are oftentimes linked in subject literature. In other words, studies on stereotyping, awareness and bias, excellence and non-discrimination, are framed through the observations, and actions to alter the climate of general knowledge production, research environment and funding schemes updated.

The persistent underrepresentation of women vis-à-vis overrepresentation of men in Science, Technology, Engineering, and Mathematics (STEM) elicited a debate of not only the causes but also the potential mechanisms able to counter this imbalance and gender inequality (e.g. Blomkvist et al. 2010; Hasse, Trentmoller 2008; Ceci, Williams 2011; Chesler et al. 2010; Cunningham 2013; Dever, Morrison 2009; Hill et al. 2010; Kelly 2016). Most commonly, the possible factors contributing to the discrepancy of women and men in STEM jobs, include a lack of female role models, gender stereotyping, and the already covered less family-friendly flexibility in the STEM fields (Beede et al. 2011: 5). According to Williams et al. (2014) the numbers of women missing from STEM, given the current rates of training in science, technology, math, and engineering persist, will mean a one million deficit of engineers and scientists in the US (see also Etzkowitz et al., 2000).

In recent UPGEM study, Hasse and Trentmoller (2008) demonstrated that masculinist organizational culture is not monolithic, but rather operates differently across various states. In physics, "the directive force of the organization of cultural knowledge about how best to act in everyday life as a physicist" formulated three different leading ideal types as cultures. These scientific cultures were typified as Hercules, the Caretakers and the Worker Bees. The summary of the differences between the driving forces in these three internationally divergent instances of cultural enactments can be seen in the table below (Hasse, Trentmoller, 2008:97; see also Godfroy, Genin 2009).

Cultural models	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Work relation	Physics is the only thing	Physics is everything but must be socially acceptable	Physics is not everything in their life
Workplace Identity	Focus is on ego	Focus is on the group	Focus is on the task and family and friends
Competition	1-on-1 fights using all means available	Group versus group	Uninterested in competition
Power relations	Anti-authoritarian with hidden power games	The group requires young members work their way up	Formal hierarchy

Gender in the cultural models	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Gender	Used as a negative element e.g. in competition	Acceptance of gender roles in relation to groups and not used negatively e.g. in competition	Not used negatively in e.g. competition

In their recent review, Savonnick and Davidson noted that "culture and representations play an important role in perpetuating gender bias within and beyond academe" (2016: str?). Cultures – on the level of workplace, organizations in a nation-wide context, as well as pan-nationally, they constitute conditions to which everyone must adhere to, scientists notwithstanding. Male culture was foregrounded by early-career physicists interviewed by Whitelegg et al. (2002) interviewees there mentioned the 'lads' culture of 'going down the pub' after work to discuss work/research. This type of "boys club" were alluded to be needed for success, forced women to partake in them to prove they are part of the team, even though conversations verged towards "sports and girls" on-site. Moreover, "the women reported that their male colleagues felt that it was OK to ask a woman out to the pub or for a meal to discuss work, but the women felt unable to do the same because "*it wouldn't look professional*" (Whitelegg et al. 2002). The female physicists perceived their departmental culture as confrontational, self-confident, self-assuring, and reliant on men sharing of new ideas and contacts amongst themselves. Women fall victim to the dominant "way of doing things", with one scientist saying "*I think women in a scientific environment really do have to … be more male in a way. They do have to try not to change the system too much, but try to adapt to the system*".

Physics research communities exhibiting masculinized notions of physics was further studied in recent project entitled "genderDynamics. Disciplinary Cultures and Research Organizations in Physics". It was conducted in German universities, non-university research institutions and excellence clusters, and examined the entanglements and disentanglements of gender cultures and disciplinary cultures for the case of different physical sciences (Erlemann 2014; Lucht 2016).

These and other studies demonstrate that "the discipline of physics is not only dominated by men, but also is laden with masculine connotations on a symbolical level, and that this limited and limiting construction of physics has made it difficult for many women to find a place in the discipline" (Gonsalves, Danielsson, Pettersson 2016: 1). Physics laboratories are especially seen to be the arenas for masculine performances, comprising of "physical skill, the ability to use machines, and (…) creativity or tinkering in relation to the use of machines" (Gonsalves, Danielsson, Pettersson 2016: 13; see also Traweek 1992; Pettersson 2011; Dasgupta 2016). Similarly the masculine norms of long working hours and international mobility contribute to the construction of the ideal worker, who is productive, as well as committed and dedicated to science. Apart from the dimension of symbols and images, the norm of masculinity is also manifested in interactions, and mental constructs. In the interactional dimesion, there exist "discrimination, sexual harassment, and the social expectation that a female physicist should act as if she were one of the boys" (Rolin, Vainio 2011: 40). In the mental dimension, some female physicists adopt "the strategy of behaving as one of the boys in order to cope with a male-dominated working environment". (Rolin, Vainio 2011: 40-41).

Leading the proceedings of the NAS events and agenda, Moss-Racusin et al. (2012: 16474) acknowledged that gender biases stem "from repeated exposure to pervasive cultural stereotypes that portray women as less competent but simultaneously emphasize their warmth and likeability compared with men". Gender bias is salient and pervasive on the general level, but particularly necessitates attention that is discipline-specific. This is because various fields reproduce the patterns of uniqueness in regard to protocols of hiring, promotion, tenure, assessment, and similar aspects. Though methods, forms and metrics may vary by branch or field, they are atypically gender-blind and commonly mirror gender bias present in a given setting (Savonnick, Davidson, 2016). Williams et al. (2014) see at least two reasons behind the STEM fields being fertile grounds for bias. Firstly, tokenism studies elaborate on the high probability of bias when women make up less than 15% – 20% of a given field, which is common in many fields of science, including physics. Secondly, Moss-Racusin et al. (2012) and Castilla and Benard (2010) tackle the philosophy of science and find that sciences that perceive themselves as objective, numbers-based and meritocratic, tend to exhibit much more actual proneness to bias.

While being concerned with the negative outcomes of organizations non-inclusive towards women in academia is not new (e.g. Rossi 1965, De Peslouan, 1974) and has grown considerably, less consensus can be observed in regard to what the root causes behind the women-excluding organizational cultures (Smeding 2012). Halpern et al. reviewed considerable number of literature and, although they supply a number of biology-driven and evolutionary concerns, they also point out that "a wide range of sociocultural forces contribute to sex differences in mathematics and science achievement and ability—including the effects of family, neighbourhood, peer, and school influences; training and experience; and cultural practices" (2007: 2). In the realms of early experience, biological factors, educational policy, and cultural contexts affecting women and men who pursue advanced study in science and math, gender stereotyping is one of the key patterns.

Although some of them have boasted more explanatory power than others, the following are the culture-related perceived causes of women's absence in research organizations in STEM:

- biological differences between men and women
- girls' lack of academic preparation for a science major/career
- girls' poor attitude toward science and lack of positive experiences with science in childhood
- the absence of female scientists/engineers as role models
- science curricula are irrelevant to many girls
- the pedagogy of science classes favors male students
- a 'chilly climate' exists for girls/women in science classes
- cultural pressure on girls/women to conform to traditional gender roles
- an inherent masculine worldview in scientific epistemology (see Blickenstaff, 2005).

The negative effect is quite straightforward as women are perceived as having lower capacity of dealing with numbers (Cejka, Eagly 1999) and prevalence to handle words rather than things (Lippa 1998). This in turn translates to girls and women loosing self-confidence, lacking in performance, and ultimately losing interest in pursuing a career in the disciplines that are counter-stereotypical, especially STEM field as the pinnacle of masculine areas in research (Eccles et al. 1990, Jakobs 1991). The stereotype is threatening in way that negative views may be exposed to a group's unjust confirmation and, effectively, hinder and underline girls' achievements in mathematics and adjacent subjects[32].

Across studies, wider societal perceptions usually associate SET/STEM occupations with men (Glover 2002, Ivie et al. 2003, Lewis, Humbert 2010). The male-dominated workforces, by design, tend to be operating with a masculine culture (Lewis, Humbert 2010). That is, they promote and value individualistic rather than collaborative behaviours, with commitment defined in terms of masculine norms of long working hours and total availability (Glover, 2002). Some evidence suggests that women in science deny the existence of the gendered processes and power differentials altogether as a way of resistance (Benkert, Staberg, 2000) or, alternatively, adopt male values and practices as a strategy to survive or thrive (Lewis, Humbert 2010). Once again, the STEM environment reflect the ideology of an ideal worker who has no family commitments (Rapoport et al. 2002). A critical mass of women scientists in itself is not sufficient to bring about systemic change in organisations based on male values and practices (Glover, 2002). Nevertheless a critical mass of women in a range of organisations in various sectors tends to be associated with greater institutional pressure on employers to introduce policies on work-life balance (den Dulk, van Doorne-Huiskes, 2007), which may be a necessary first step in challenging male structures, cultures and practices. When studying women in science, Xie and Shauman (2003) found that most of the observed sex differences in research productivity and alike could be attributed to demographic characteristics and, most importantly, the structural features of the employment setting. Below some key data for understanding the European context is provided.

Gender and organizational culture in research: European data

- ***For many years, women in the EU-28 have been significantly under-represented in research & innovation outputs (She Figures 2015, see also Beede et al. 2011)***
- Under-representation is particularly severe in 'innovation' (patent applications for inventions), rather than in 'research' (scientific publications): since 31% of publications had a woman corresponding author between 2011 and 2013, whilst a mere 8.9% of patent applications registered a woman inventor (2010-2013) for EU-28 (*She Figures* 2015)
- The proportion of scientific publications by women corresponding authors slowly increased in the EU-28 between 2007 and 2013, including in engineering and technology (CAGR (Compound Average Growth Rate) at 3.9%). A similar increase was observed for inventorships (with an increase of 2.2% from 2002 to 2013, *She Figures* 2015)
- At EU-28 level, women and men corresponding authors publish their scientific papers in comparably influential journals. Though fewer scientific publications' first authorship is attributed to women than men, on average they publish their results in journals of equivalent prestige (*She Figures 2015)*
- The gender gap in the funding success rate at the EU-28 level is slowly declining, though the success rate for men is still higher than that for women in 70% of countries (*She Figures 2015)*
- Between 2010 and 2013 in the EU-28, the proportion of scientific publications with a gender dimension ranged from virtually zero in agricultural sciences, engineering and

[32] The impact of stereotype threat on womens performance in physics is further examined by Marchand and Taasoobshirazi (2013), Eddy and Brownell (2016) and Kelly (2016)

technology, and natural sciences to 6.2% in the social sciences. This further excludes or marginalizes women in these disciplines (*She Figures 2015)*.

1. Gender stereotyping and bias across the life-course

Different views upon the explanations of women's paucity in the role of scientists contain also the issues of cultural misrepresentation. Of all the sciences in many countries, including the leading economies, physics continues to have the lowest representation of women. While small improvements have been made and female physicists "could be the majority in some hypothetical future yet still in their careers experience problems that stem from often unconscious bias" (Ivie, Tesfaye, 2012). Luckily, it is now recognized that biases "function at many levels within science including funding allocation, employment, publication, and general research directions" (Lortie et al. 2007:1247; see also Cunningham 2013; Eccles et al 1990; Ivie, White 2015).

a. Young girls and science

As early as at the beginning of 1980s, the biological explications of gender differences were somewhat rejected and rebutted. For instance, Saraga and Griffiths claimed in 1981 that "the relationship of girls to science, and their performance in it, are too complex to be understood in terms of one factor, but that several factors must be integrated in a broader understanding of the social context in which science is carried out, and in which socialization takes place. (…) Theories couched in biological terms cannot be sustained. (…) it is not sufficient just to consider the development of girls in relation to science—the development and practice of science must also be discussed" (1981: 85). However, the arguments that nevertheless allude to biological sex rather than cultural gender continue to be put forward (e.g. Halpern et al. 2007). Very recently, Ceci and Williams debated a mixed-approach to career preferences, adopting a framework that focuses on adolescent girls' selection of careers related to people rather than things (2014). According to the authors, preferences account for burgeoning numbers of girls in such fields as medicine and biology, concurrent to weaker presence in math-intensive fields like computer science, physics, engineering, chemistry, and mathematics. This helped understanding that preference prevail in choices, even when math ability of girls and boys is equated (Ceci, Williams, 2014).

Quite clearly, girls are at the centre of cultural causes of later absence in science, which were linked to the missing female role-models, and the constructions of girlhood that are far removed from interest in science, gathering positive experiences from contact with science, as well as irrelevancy of science curricula built around cars, machines, vehicles etc. for young girls. As argued by Lewis and Humbert (2010) from the early age science-derived role-models for girls are rare, while cultural pressures exerted on girls to conform to traditional gender roles that exclude a scientific career run high (Blickenstaff, 2005). Williams and Ceci (2012:139) bring about explanations from some scholars about the effects of early socialization practices that end up in girls and women dropping out of math-based endeavours or change their focus. Arguments about early-life segregation of toys and slogans, then translate into uneven treatment by middle-school already. More specifically, "Barbie dolls proclaiming "Math class is tough," middle-school math teachers calling on boys more than girls" in high-school urge girls to be cheerleaders or writers instead of scientists.

According to Betz and Sekaquaptewa (2012), women in STEM are often labelled as unfeminine, which is a costly social categorization conducive to dropping out from these fields despite talent and interest. At the same time, studies conducted with middle-school girls by the authors suggest that inclusion of female STEM role models who are counter-sterotypicyet-feminine led to no success among young girls. These results did not extend to feminine role models displaying general (not STEM-specific) school success, indicating that feminine cues were not driving negative outcomes. All STEM-de-identified girls considered a successful combination of femininity and success highly unlikely, thusly calling for better-suited campaigns at this level (see also Neuschatz, MacFarling 2003).

In that sense, it is important to note that Dabney and Tai (2013) found that female physicists report the significance of both early and long-term support outside of schooling. Such assistance and encouragement offered by family was seen as essential to their persistence within the field. A greater focus on informal and out-of-school science activities for girls and young women should therefore be envisioned, especially those that involve family members. Interventions at the early-life and parents-inclusive in nature, may impact entrance into a physics career later in life. For female respondents in this study, entrance into physics occurred through encouragement, support, hobbies, and shared interests with their parents and family, thus signalling the importance of early interest in science and participation in unstructured science activities.

b. Bias among students and academics

Gender stereotyping continues at the later career-stages, wherein conscious and subconscious biases eliminate or decrease women's chances. Pursuing postgraduate education is a first step in the career of many – male or female - researchers. In 2012, the European Commission warned that "while the proportion of women at the first two levels of tertiary education is higher than that of men, the proportion of women at the PhD level is lower" (European Commission, 2012: 35). In line with the regional and Europe-wide ambition to encourage more 'research-intensive' economies, a call has been issued to attract more doctoral candidates. In addition, it was argued that efforts must be made to tackle "stereotyping and the barriers still faced by women in reaching the highest levels in post-graduate education and research" (European Commission, 2011: 5; EC 2015: 20). However, the lack of female career models in early-life continues throughout education and is also said to contribute to women leaving sciences and opting out from pursuits of advanced (postgraduate and doctoral) degrees.

The pattern is exacerbated by the persistent unavailability of female scientists who were also fulfilled as mothers (Mason et al. 2013; Wolfinger et al, 2010). What is more, Whitelegg and colleagues (2002) argued that while the overall levels of harassment reported by female physicists is low, older male in the discipline (aged over 55) were perceived as having stereotyped attitudes to younger women postgraduates and employees. This views were named as a barrier to career progression for women.

c. Consequences of stereotyping

Gender stereotypes do not operate in a vacuum, but are rather strongly linked with consequent choices to stay or leave academic research, particularly for female physicists (e.g. Newsome, 2010; Giles et al. 2009; Godfroy, Genin 2009; Hodgson et al. 2000).

During a longitudinal 5-year survey of the perceptions of problems for women and men in the fields of science, math, and engineering among undergraduates, Hartman and Hartman (2008) identified little significance of exposure towards female role models in the fields among young women. This may suggest that, by the time that students have already made major choices career-wise. Further, exposure to professional experiences reduced the perception of problems in the field, especially alleviating the negative outlook for women. Working outside of academia related to women's intentions to persist in the field after graduation, yet effectively reduced a potential to take on academic track. This coincides with Newsome's findings on young chemists in the UK, where only 12% of third year female PhD candidates wanted to pursue a career in academe, compared to 21% of men. Newsome reports that female participants in the study described the obstacles they faced in doctoral study and wished not to continue in their future careers. These features encompassed lack of mentorship, feelings of isolation and exclusion (particularly within research groups), discomfort with the masculinist culture of research environment, and apprehensions that poor (though statistically average) experimental success rates would reflect negatively on their competence (the "Prove-it-Again" pattern). What is more, women perceived science research careers as "too all-consuming, too solitary and not sufficiently collaborative," incompatible with their relationship and family goals, as well as demanding sacrifices they were not willing to make (related to femininity and motherhood).

Further, there was a meta-finding that women realized that these fields are biased against them and decided not to engage in an unequal fight against bias (Newsome, 2010), so by then the damage of bias has been done and irreversible. In another study, however, Smelding's (2012) underlines that implicit gender stereotyping was not related to math performance for female engineering students, unlike for women in other disciplines (see also Nosek et al. 2002). In other words, the work on stereotyping is promising in fostering bias-avoidance, because otherwise present strong implicit gender stereotypes are directly linked to discriminatory behaviours in the workplace. Such work, however, must target men and women across the disciplines to alleviate societal prejudice more generally.

Still, evidence about bias and discrimination for women in STEM has been mixed, and conventional explanations are often given as the pull of children and early-on life-choices against pursuing careers in math and science (Moss-Racusin et al. 2012). On the one hand, some studies conclude with quantity-not-quality-driven explanations: the relatively low percentage of women stems from fertility and preference factors, which cannot be seen as "caused by discrimination" in STEM (Ceci et al. 2009, 2011; Ceci & Williams, 2014).

On the other hand, recent studies equally propose that gender bias is to blame (Williams et al 2014). For instance, one project discovered that even when math skills were identical, both men and women were twice as likely to hire a man for a job that required math (Reuben et al. 2014); the bias reached up to 90% level for mistakes occurring in favour of men. Another study yielded a discovery that in academic laboratories in elite universities, male (but not female) scientists employed fewer female than male graduate students and post docs (Sheltzer & Smith, 2014). Finally, Moss-Racusin et al. (2012) used a double-blind randomized design to examine bias of science faculty through random assignment of male versus female name to an application for a post. The authors discovered that both male and female research and teaching faculty exhibited a bias against female undergraduate students, evaluating them as less competent, hireable, and qualified, and offering them less funding and mentorship. For example, based on application materials, a candidate for a laboratory manager position was deemed more competent, qualified, and hireable if they had a male name. The authors call for a conscious intervention that addresses faculty gender biases: "The dearth of women within academic science reflects a significant wasted opportunity to benefit from the capabilities of our best potential scientists, whether male or female" (Moss-Racusin et al. 2012: 16478).

Even in the gender-more-progressive science fields, gender bias persists in hiring. Sheltzer and Smith (2014), for instance, demonstrated that elite male faculty in the life science employ fewer women, despite the fact that women receive more than one-half of the doctoral degrees in biology-related fields. They remain, nevertheless, drastically underrepresented among life science faculty. In this study, Jason M. Sheltzer and Joan C. Smith found that male faculty members tend to employ and train fewer female graduate students and postdoctoral researchers than their female faculty colleagues. Through analysis of publicly-available data on the composition of biology laboratories they found that "faculty members who are male train 10–40% fewer women in their laboratories relative to the number of women trained by other investigators.

Therefore, bias is often implicit or unintentional, "stemming from repeated exposure to pervasive cultural stereotypes that portray women as less competent but simultaneously emphasize their warmth and likability compared with men" (Racusin et al. 2012; see also Williams et al. 2014; Cunningham 2013)[33]. In a study of women of colour in science, Williams et al. (2014) revisit and build upon the classic 1976 study and cumulatively present the four main gender biases practices in STEM. The authors document patterns and review literature reflective of four distinct ways in which gender bias operates in sciences and academe. These are here expanded with further examples from various studies:

1. <u>Prove-it-Again:</u> women need to provide comparably more evidence of competence in order to be seen as equally competent as men. This is a form of descriptive gender stereotyping which relies on a perceptions that women *do not fit* the science work culture, and that there is an incompliance between being a woman and being a scientist (Nosek et al. 2002; Moss-Racusin et al. 2012). Chesler et al. (2010: 1933), talking about the "pipeline still leaking", argued that "[s]ubstantial research shows that resumes and journal articles were rated lower by male and female reviewers when they were told the author was a woman; similarly, a study of postdoctoral fellowships awarded showed that female awardees needed substantially more publications to achieve the same competency rating as male awardees". Hill et al. (2010: 24), Lortie et al. (2007) and Sheltzer and Smith (2009) also pointed out that "Prove-it-again" is salient in the processes of review and hiring, while Wenneras and Wold (1997) calculated that a female postdoctoral applicant needed to publish at least three more papers in a prestigious science journal or an additional 20 papers in lesser-known specialty journals to be judged as productive as a male applicant. Conversely, certain regions witness some progress in this area, as reported finding from 1997 Wenneras and Wold study has not been repeated in their 2004 review, which found no bias in productivity assessment of female PIs in grant proposals.
2. <u>The Tightrope:</u> women must navigate the perceptions of being seen as either overly feminine thus incompetent, or as too masculine to be meshing well with colleagues in a work environment and thus unlikeable (Cuddy et al 2004). This is a form of prescriptive stereotyping originating from the fact that science is seen as requiring masculine qualities, yet women are never expected to abandon their femininity by the broader society. Thus women often find themselves pressured to take on dead-end roles, from acting as administrative assistants to being expected to mentor everyone else's students in addition to their own (Williams et al. 2014). Even in masculinist environment, women face backlash for behaving in stereotypically masculine ways, such as being assertive (Prentice, & Carranza, 2002), angry (Brescoll & Uhlmann, 2008), or self-promoting (Rudman, 1998).
3. <u>The Maternal Wall:</u> motherhood, discussed in detail earlier in this report, is by far the most damaging with regard to gender bias (Ivie et al. 2002; Mason, Goulden 2004;

[33] Gendered bias has been proven to be present in college students' evaluations of their teachers. Both male and female students underrated their female high school physics teachers and students with a strong physics identity showed a larger gender bias in favor of male teachers than those with less of a physics identity (Potvin, Hazari 2016).

Ceci, Williams, 2009). This form of descriptive stereotyping depends on a belief that women's work commitment and competence disappear after they have children (Correll et al. 2007). What is more, there is an element of prescriptive stereotyping found here as well in a way that mothers who remain indisputably committed are penalized as well for not adhering to a cultural gender norm of maternal dedication (Benard & Correll, 2010).

4. Tug of War: Sometimes gender bias against women fuels conflict among women. This stems from the fact that women as well as men are biased against women in traditionally masculine domains (e.g. Moss-Racusin et al, 2012). Studies show that women who experience discrimination early in their careers tend to distance themselves from other women (Derks et al. 201). Commonly this strategy is referred to as the "queen bee".

In an academic world, Devis and Morrison (2009) see these areas as reflective of the long-standing gendered division of academic labour that sees women more concentrated in teaching activities while men focus on research and publishing (Bagilhole & White, 2003; Park, 1996); the tendency for women to experience less secure and less continuous employment (Allen & Castleman, 2001; Lundy & Warme, 1990; Sellers, 2007) and to have less confidence in their abilities or achievements and less access to academic networks (Britton, 1999; Deane, Johnson, Jones, & Lengkeek, 1996; Doherty & Manfredi, 2005); choice of discipline area (Bell & Bentley, 2005; Kirkpatrick, 1997); as well as work-life pressures (Forster, 2000; Probert, 2005).

Following an intersectional approach, Williams et al. (2014) have recently examined the "double jeopardy", that is the binding of ethnicity and gender. Gender bias in laboratories exists, and it is prominent for women of colour: 100% of the sixty scientists interviewed for Williams et al.'s study (2014) reported encountering one or more patterns of gender bias and an earlier study found that 97% of the Black women interviewed were aware of negative stereotypes of Black women, while 80 percent had been personally affected by them (Jones & Shorter-Gooden, 2003). Women of colour face "double jeopardy" because they encounter race as well as gender bias and have the "bee" syndrome attributed to the personality problem of an individual woman, rather than a gender bias in the environment. Similarly, Malone and Barabino (2009) demonstrated how students of colour suffer from invisibility/lack of recognition, being in the loop, racialization, and the integration of their identities. The issues of race in the research laboratory complicates the already tenuous dialectic between the social and the individual implications of gender bias (see also Herzig 2004; Rosa, Mensah 2016).

In sum, bias continues further down the pipeline, as women become increasingly disenfranchised once they enter science careers in academia. Ceci and Williams (2014) remind women's accounts of a "chilly climate", already mentioned by Newsome's respondents above (2010) and by Blickenstaff more broadly (2005). In the study of early-career female physicists in the UK by Whitelegg et al. (2002), gender bias seemingly functioned differently depending on the respondent's age. Different perceptions were expressed by younger and older women about gender-related barriers or constraints they have met in pursuit of their physics careers. In a survey of women at the Institute of Physics (IOP), only 15% of the younger women (aged under 30) said they had encountered gender barriers compared with 45% of older women.

Note, however, that the attrition among the young women remained high, with only one out of four remaining in science. Dislike of a "male culture" and "atmosphere" of physics research centres and departments was a commonly given reason for leaving academia. There was also a conviction that it is nearly impossible for a women to ever accomplish a senior physics post, which are in turn explained by the lack of options for balancing a research career with a young family, as well as women tending to follow their partners with moves, essentially removing themselves from physics community. Although young women often do not perceive these conditions as gender barriers, they certainly are notions stemming from bias that impede women's success in the field. Ivie and Ray confirmed the prevalence of "chilly climate for women in physics" (2005: 21), stating that the atmosphere is tangible in the everyday work of female physicists who are often still told through actions rather than words that physics is a man's world. This unwelcoming cold-reception impacts upon unequal pay and promotion schemes; devaluing of women's work styles and biased assessment of their efforts and performance (Bronstein, Farnsworth, 1998), as well as persistence of old-boys' clubs that isolate women in a conscious or awareness-lacking manner.

2. Raising and assessing gender awareness

Global survey showed that female physicists are generally exposed to lesser access to resources and fewer opportunities to advance their careers (Ivie, Tefaye, 2012:51). Scientific community, in general, fails to acknowledge that allocation of resources, such as funding and lab space, that are needed to contribute to the scientific body of knowledge, are gender-dependant.

As one example, Cotta et al. (2009) discuss how the main Brazilian funding agencies, CNP and CAPES, have introduced gender awareness projects in recent years. This initiative is a starting point for changing the percentage of women at all career levels in physics, but particularly at the top. Thus far, captured change has been mild and the most likely reason is that the decision committees consist mostly of male researchers. In spite of program's implementation, prejudice was still plaguing the evaluation process. Still, the average number of publications of the female researchers is 72% higher than for the male researchers at the entrance level, indicating that it is harder for women to enter into the research system.

Similarly, the European Research Area (ERA) Survey points the way to the actions that research organisations can take, such as recruitment and promotion measures, targets to ensure gender balance in recruitment committees, flexible career trajectories (e.g. schemes after career breaks), work–life balance measures and/or support for leadership development. According to the ERA Survey of 2014, around 36% of research performing organisations (RPOs) indicated that they had introduced gender equality plans in 2013 (EC 2015: 6) In 26 out of the 37 countries for which data are presented, more than half of the responding RPOs had work-life balance measures in place. However, targets for recruitment committees and support schemes for leadership were relatively unusual (in most countries, less than a quarter of RPOs had these measures in place in 2013) (EC 2015:100).

On a meta-level of fostering intra-discipline change, Phipps (2006) studied policy, activism, and educational activity around the issue of women's under-representation in science, engineering, and technology since the 1970s. She discovered that flourishing literature on gender and STEM rarely translates to inclusion of other than neoliberal feminist framework. More specifically, women in STEM were found unlikely to claim allegiance with feminism, and the field-activists have not tapped into solutions offered by critical, radical and postmodernism feminist perspectives to entice change. Phipps argued that the activists' 'feel for the game' incorporates a disposition towards reformism and 'neutrality' that relies in part on a dis-identification with feminism, this staggering the progress in the field.

3. Conclusions and Recommendations

- Cronin and Roger (1999) point out that initiatives to bring women and science together focus on one of three areas: (1) attracting women to science, (2) supporting women already in science, or (3) changing science to be more inclusive of women. All these initiatives are related to the prism of culture in the perception, practice and retention and, as such, need to be implemented together (Blickenstaff 2005)
- Almost all of the articles call for conscious, structured, institutional efforts to counteract unconscious and unintentional gender biases. (see also Savonnic, Williams, 2016). An exception is by Ceci et al. (2011), who claim that not everything should and needs to be explained with a bias framework. Although real “barriers are still faced by women in science, especially mathematical sciences, historic forms of discrimination cannot explain current underrepresentation”, meaning that redirection of resources should focus on current rather than historical causes of women's absence in STEM careers (ibid, 2011: 3158)
- In efforts to avoid women’s and parents’ exclusion, professional meetings should be scheduled in a way that does not collide with childcare responsibilities (e.g. during school hours) (Ceci et al. 2009). As one example, the UC-Berkeley's *Family Edge* program provides high-quality childcare and emergency backup care, summer camps and school break care, as well as offers re-entry postdocs. There and at some other institutions, usually at the top-level, the administration instructs committees to ignore family-related gaps in CVs. At the same time, as Ceci and Williams argue, more research into solutions is needed to assess their effects and promises (2011)
- Transparent schemes of salaries, bonuses and income incremental increases need to be implemented and, ideally, appropriately sensitive to career-breaks. Research in this realm should examine in more detail the connection between gender and job titles, and their entanglement with remuneration (Ivie, Ray, 2005)
- Going beyond structured institutional support, Dabney and Tai (2013) additional suggest policy proposals around an indirect support system through peers and support groups for women in physics: “while women are often underrepresented in these programs, peer socialization and workshop activities can be developed to encourage the inclusion of women into these physics programs and departments as future faculty members. Finally, women support groups can be developed across university STEM based departments thereby providing female physicists a social network and critical mass of peers both within and outside of the university” (Hodgson et al. 2000). There is a paramount importance of the quality and availability of mentoring programs for new academicians (O’Laughlin, Bischoff, 2005).
- Drawing on subfield examples of good practices, more specifically positive gender experiences in Physics Education Research (Barthelemy Van Dusen, Henderson 2015)
- Awareness campaigns against stereotyping must target predominantly men (Smelding 2012), while awareness of bias and ways for dealing with systemically legitimized “boys clubs” should be made available to women (Whitelegg et al. 2002)
- Wynarczyk and Renner (2006) argued that WLB policies trump other STEM-specific barriers in holding back career development among women scientists. As an idea of an intervention, however, it needs to be contextualized because the gaps are noted across many sectoral and national contexts, then translating into policy and culture clashes science (Webster, 2005)
- Broadening the scope of gender inspirations is needed, as gender/STEM activist exhibit rehashing of the same ideas, conformism to established patterns, and, in result, miss opportunities for introducing novel measures (Phipps, 2006)

- According to Blickenstaff (2005), the amelioration of research cultural environment must begin at an early education level rather than try to mitigate the later challenges. She proposes to address the following recommendations:
    - ensure students have equal access to the teacher and classroom resources
    - create examples and assignments that emphasize the ways that science can improve the quality of life of living things
    - use cooperative groups in class, or at least avoid dividing students by sex for class competitions or in seating arrangements
    - eliminate sexist language and imagery in printed materials
    - do not tolerate sexist language or behavior in the classroom
    - increase depth and reduce breadth in introductory courses
    - openly acknowledge the political nature of scientific inquiry.

- Per Ceci and Williams, "one strategy to broaden girls' interests and aspirations involves providing them with realistic information about career opportunities (…). This intervention is not meant to dissuade girls from aspiring to be physicians, veterinarians, and biologists, fields in which women are becoming a majority, but rather to ensure they do not opt out of inorganic fields because of misinformation or stereotypes" (2009: 3161)
- For sparking and retaining interest in a career in physics in females, interventions and campaigns should not only begin as early as possible in childhood, but also incorporate parents as agents of persistent support and encouragement. Dabney and Tai (2013: 010115-7) argued that "a greater focus on informal and out-of-school science activities for females that incorporate family activities early in life may help influence their entrance into a physics career later in life. While these informal activities occurred within the home, they are not beyond the influence of education and public policy"
- Seemingly ideal is an approach going beyond the short-term remediation and specific policies to improve position of women as a first necessary step (Cockburn, 1989), yet focus on the longer agenda of working towards more systemic change and transformation to the masculinist ideals of science-employee that is assumed male and family-free (Lewis, Humbert, 2010; Bleijenbergh et.al., 2012)
- Racusin et al. (2012) as well as Castilla and Benard (2010) claim that disciplines that value "objectivity" are particularly susceptible to subtle gender biases because they are not on guard against them, unlike their colleagues in social sciences, for instance. The lack of awareness, however, does not mean that women's career decisions and whether they see doctoral studies in the sciences as a viable option is not affected. Thus, more gender-awareness trainings should generally be issued to faculty in sciences (Racusin et al.2012)
- Self-assurance of objectivism and meritocracy in STEM leads to tokenism, especially for women of colour in sciences. The conviction about being superiorly fair needs to revisited, especially for hiring committees and similar bodies (Williams et al. 2014)
- Awareness trainings must draw attention to equal distribution of "soft" and "hard" types of resources needed to advance a career in science, ranging from access to graduate students or employees to assist with research, to clerical support, research funding, and travel money. Gender-balance should be ensured within invitations to speak, serving on committees, and conducting research abroad (Ivie, Tefaye, 2015)
- Focus on productivity as number of publications might not be the best way moving forward in reducing gender bias (Fox, 2005). The performance should be studied more

in reference with levels of personal engagement with a research area, vibrancy of research environment, appropriate research infrastructure, enjoyment of the research process itself, quality feedback, and public recognition of achievements as factors likely to lead to enhanced research performance (Dever, Morrison, 2009:50; Acacio et al. 1996).

Examples of good practices:

University of York (United Kingdom). Equality Committee engaged in a review of student internship placements. In this realm, two issues were raised. First, the committee ensured that all employers benefitting from student interns embrace and obey Code of Conduct, thus limiting the scope for instances of gender discrimination, sexual harassment, etc. of female students. Secondly, placements were advertised to women in science – with the support from Athena Swan – and STEM internships increased the male/female ratio to 60/40.

University of Warwick (United Kingdom). As part of Gender Equality Objectives, data is collected on diversity among staff to ensure that needs of sexual minorities are accounted for.

Antwerp Charter On Gender-Sensitive Communication In And By Academic Institutions (Belgium): Signed by diverse institutions, the aim of the charter is to eliminate bias from all institutional communication, which may lead to perpetuating gender-based stereotypes. The institutions commit that in all diverse forms of institutional communication, through diverse channels and to diverse audience, they would promote, among others, gender-sensitive communication and unbiased portrait of women (http://eige.europa.eu/sites/default/files/egera_antwerp_charter_on_gender-sensitive_communication_in_and_by_academic_institutions.pdf).

National Girls Collaborative Project (USA). „The vision of the NGCP is to bring together organizations throughout the United States that are committed to informing and encouraging girls to pursue careers in science, technology, engineering, and mathematics (STEM).The goals of NGCP are to maximize access to shared resources within projects, and with public and private sector organizations and institutions interested in expanding girls' participation in STEM, to strengthen capacity of existing and evolving projects by sharing exemplary practice research and program models, outcomes, and products, as well as to use the leverage of a network and the collaboration of individual girl-serving STEM programs to create the tipping point for gender equity in STEM.

The project focus from 2011-2016 has been to:

1. Strengthen the capacity of girl-serving STEM programs to effectively reach and serve underrepresented girls in STEM.

2. Increase the effectiveness of Collaboratives by providing professional development focused on sustainability, organizational effectiveness, and shared leadership.

3. Maximize K-12 school counselors' access to and use of relevant, high-quality resources that increase awareness of barriers to girls' interest and engagement in STEM" (https://ngcproject.org/about-ngcp).

Final remarks and implications for interview design

The complexity of gender-relevant issues that contribute to the current situation of the women being persistently under-represented in physics is astounding. For one, the many facets of gender bias operate on very different levels: some are relevant for all women in the labour market (e.g. hiring discrimination, after-hours networking of men, motherhood penalty), some pertain to all those pursuing careers in academia (e.g. within notions around excessive working hours, perceived flexibility which nevertheless comes at a price), others are specific to the masculinist culture observed in STEM (e.g. competiveness, stereotypes), and few elusive aspects are physics-specific. Moreover, the discrepancies between findings from different countries or regions, as well as those employing divergent methodologies (e.g. qualitative versus quantitative projects) continue to impede a possibility to serve a guideline that "fits all". Instead, this report argues for targeted, specific, and contextual approaches and interventions.

Research pertaining to women in STEM is usually highly specific in terms of solutions that are seen as relatively easy to implement and wide-spread. However, the main challenge remains that the studies examine predominantly the pathways of those who persevered in the face of adverse conditions in science and physics. It is rare for the studies to incorporate a longer **biographic-perspective,** so that the question of temporality is commonly restricted to a single phase of a female physicist's life, rather than taking into account that the family demands may emerge or become altered. Frequently, the deployed mechanisms allow for a short-term and ad-hoc compensation for the "baby penalty" as tenure clocks are stopped, retooling after breaks are possible, and early-to-mid career research grant schemes extend the available leeway for incorporating family leaves. Conversely, the patterns of childlessness among top-academics, as well as high-prevalence of underrepresentation of women in the leadership positions, are rarely seen as a direct consequence of a policy and support mechanism failures at the earlier points in women's professional lives. In addition, while the mechanisms for promoting equality are in general conducive to women's perseverance, they are rarely capable of altering the more intangible problems of a "chilly climate" and masculinist culture. In such setting, discrimination is legitimized, resentment common, and traditional values of the established societal and institutional divides upheld. In turn, this culture becomes increasingly hostile and exclusionary towards all parents – men and women alike. In that sense, one paramount finding is to **include men** in research on gender in physics, especially since practices of co-hiring spouses and encouraging paternal leaves can alleviate not only the meso-level challenges for families, but, potentially, transform the overall perception of what it means to have a family as a scientist. It is also apparent that the concern with women being so few overshadows the heterogeneity among women, who may favour different solutions. In that sense, it reiterates the need to promote tailored and "choose-your-way" *work-redesign model* schemes that women can take advantage of at different times and in accordance to their lifestyle preferences. Finally, all of the best solutions cannot be beneficial if awareness of **managemen**t is low, and the attitudes hostile. Thus, the change in this realm is a prerequisite for a functioning gender-sensitive work environment.

There is a broader need to break-down the different strategies that need to be used for attracting women and girls to science, versus supporting those already on the science path, versus ensuring sense of inclusivity that makes women "be themselves" and "feel at home" in the currently masculine environments. Across these groups, there is a clear evidence for the importance of **networking,** both in the work done by women's networks, and individuals' membership in them. This translates into mentoring, which again is cross-cutting the life-course biographic perspective.

In sum, the advancements and further research need to be two-track in improving the current conditions in the given culturally and contextually specific partner organization, and, incorporate a long-view perspective to draw inferences about broader social changes around gender in physics.

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