

Foresight on new and emerging risks associated with new technologies by 2020: Workshop for EU Focal Points

European Risk Observatory

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1 Background

In early 2010 EU-OSHA commissioned a study “Foresight on New and Emerging Risks Associated with New Technologies in Green Jobs by 2020” (the Green Jobs project). The study, which ran for two years, was carried out by a consortium of the UK Health and Safety Laboratory, SAMI Consulting and Technopolis Group. It used the scenario building method to explore the development of a range of technologies in green jobs and their associated occupational safety and health (OSH) risks in three possible futures for Europe.

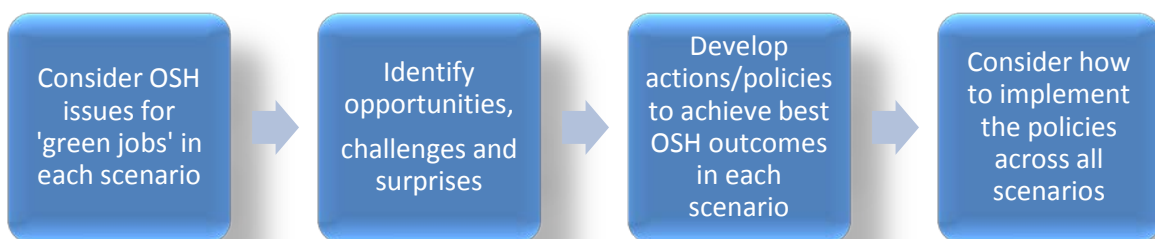
The scenarios produced are intended to inform EU policy makers, Member States’ governments, trade unions and employers, so that they can take decisions to shape the future of OSH in green jobs towards safer and healthier workplaces.

Scenario building is an established method for exploring the future in a way that allows a range of drivers of change to be taken into account. They are not predictions, but descriptions of possible futures that provide a structure for strategic thinking to inform planning. As the future is likely to contain elements of all these scenarios, envisaging them helps to anticipate the future.

This report describes a workshop, based on the Green Jobs project and held in Bilbao on 12 and 13 November 2013 for the EU-OSHA Focal Points. The aims of the workshop were:

- To raise the Focal Points’ understanding of and interest in the findings of the EU-OSHA project “Foresight on New and Emerging Risks Associated with New Technologies in Green Jobs by 2020”;
- To demonstrate to the Focal Points the use of scenarios to support strategic discussions and their application to policy making.

The development of strategies or policies is a complex process that often does not adequately consider the future environment in which the policies will need to be successful. The use of scenarios to support this process was demonstrated at the workshop, using the following steps:



Focal points were taken through the process of identifying potential future OSH risks in each scenario and formulating policies or actions to deal with these. In a final exercise, they used a process known as wind-tunnelling to compare the impact of policies or actions in the different scenarios. It was intended that achievement of the objectives shown above would enable the Focal Points to better act as a multiplier to disseminate the EU-OSHA foresight results in their own countries and to encourage the application of scenarios to national policy making processes.

It is important to note that the policy development and testing exercises were undertaken to demonstrate the contributions that scenarios can make to this process. They were not intended to be decision making exercises, as this would be a considerably longer process requiring further analysis.

The workshop was held over two half days. Twenty-six Focal Points and six EU-OSHA staff attended. The event was facilitated by representatives of the UK Health and Safety Laboratory and SAMI Consulting, who had carried out the Green Jobs project.

The Agenda for the workshop is at Annex 1 and a list of attendees is at Annex 2.

2 Introduction

2.1 Welcome and Introduction to the Foresight project

Emmanuelle Brun (EU-OSHA) gave an introduction to EU-OSHA's foresight activities, the relevance of anticipating new and emerging OSH risks from new technologies in green jobs to the OSH Community Strategy 2007-2012, and the role of scenarios. Scenarios are a useful tool to:

- Anticipate possible new and emerging risks;
- Mainstream OSH into other disciplines;
- Encourage people to 'think outside box' in a neutral context (the future) removed from the constraints of the present in order to generate new insights; and
- Test policies against different assumptions to develop future-proofed, surprise-resistant policies.

2.2 Workshop Introduction

John Reynolds (SAMI Consulting) gave an introduction to the workshop proceedings and 'rules' and the timetable for the event. The objectives of the workshop were:

- To introduce the project and the three scenarios for OSH in green jobs to 2020;
- To identify the key OSH challenges and opportunities in each scenario;
- To review actions/policies to achieve a good OSH outcome in each scenario;
- To form conclusions on the use of the scenarios to determine OSH priorities.

In an introductory exercise in plenary session, delegates were invited to offer their priorities for the workshop and what they hoped it would achieve. Responses were grouped into two main areas:

- To learn about the scenario method.
 - How scenarios can be used in OSH;
 - Case studies for the use of scenarios;
 - How Focal Points can use the scenarios in their own work.
- To learn about green jobs and the associated OSH issues.

Further questions concerned the definition of green jobs and whether OSH risks in green jobs are necessarily new. Emmanuelle Brun explained that there are several definitions of green jobs. The broadest include any job that is associated with preserving or restoring the environment ⁽¹⁾, which is the one that served as the basis for the project. However, the types of green jobs addressed in EU-OSHA's project were naturally narrowed down by the scope of the project focusing on the impact of eight new technological areas in green jobs. The focus of the project was OSH issues rather than environmental considerations.

Some of the risks identified in the project are new, while others may be "old" risks but found in new situations, or in new combinations, involving different workers' groups, possibly untrained, which equally brings new challenges to OSH.

¹ Definition developed as part of the joint UNEP, ILO, IOE, ITUC Green Jobs Initiative (UNEP (2008), *Green Jobs: Towards decent work in a sustainable, low carbon world*, United Nations Environment Programme. Available at: http://www.unep.org/PDF/UNEPGreenjobs_report08.pdf

3 How foresight and scenarios can support policy-making and introduction to the EU-OSHA scenarios

John Reynolds then gave a presentation on foresight and scenarios, which covered the need for foresight, the nature of scenarios and their use. This was supported by several case studies.

Anticipating the future, or foresight, is important as Europe and the broader world are experiencing a period of probably unprecedented uncertainty. It is also important to gain an understanding of the forces driving accelerating rates of change and innovations. Foresight challenges predetermined views, allows a wider range of options to be considered and should lead to more robust and lower risk policies. It should also help to identify potential opportunities to influence the future and early warning signs of potential developments.

The Green Jobs project comprised three Phases:

- Phase 1: Identification of key contextual drivers of change shaping green jobs;
- Phase 2: Identification of key technologies that could create new and emerging OSH risks in green jobs;
- Phase 3: Development and validation of scenarios describing the development of the key technologies selected and the new and emerging OSH risks to which they could lead, and demonstration of their potential value in policy making.

In Phase 1 a literature study, a series of 25 interviews with key people, a web-based survey and a voting exercise were used to identify the 16 drivers of change.

In Phase 2 a literature study, a series of 26 interviews with technical and OSH experts, a web-based survey and a workshop were used to identify 8 technologies and technology areas. These were:

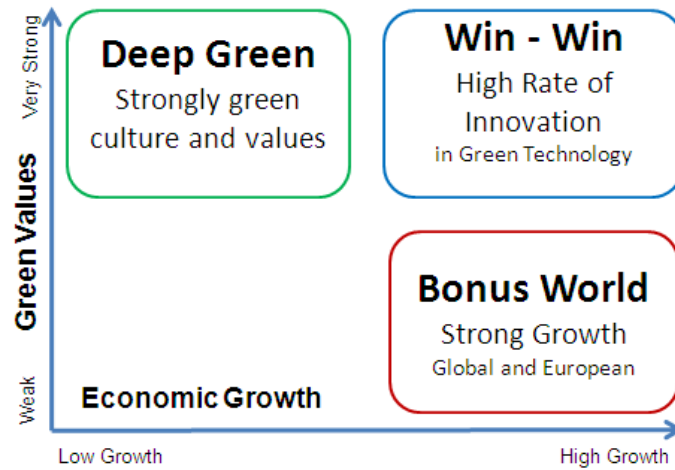
• Wind energy (industrial scale)	• Green transport
• Green construction technologies (buildings)	• Green manufacturing technologies and processes, including robotics and automation
• Bioenergy and the energy applications of biotechnology	• Electricity transmission, distribution and storage, and domestic and small-scale renewable energy
• Waste processing	• Nanotechnologies and nanomaterials

In Phase 3 the drivers from Phase 1 were reviewed and three broad clusters were identified, which were selected as the axes around which the scenarios would be built. These were:

- Economic Growth
- Green Values
- Rate of Innovation in Green Technologies

The three broad drivers of future change, identified above, were used as axes to generate three possible scenarios for 2020. The positions of the scenarios relative to two of the axes are shown below in Figure 1.

Figure 1:: Economic growth and green values axes



The third axis is shown below in Figure 2 and shows the relative progress of green innovation, as distinct from other innovation, in each of the three scenarios. The three axes for the scenarios are brought together in a tabular form in Table 1.

Figure 2: Innovation Axis

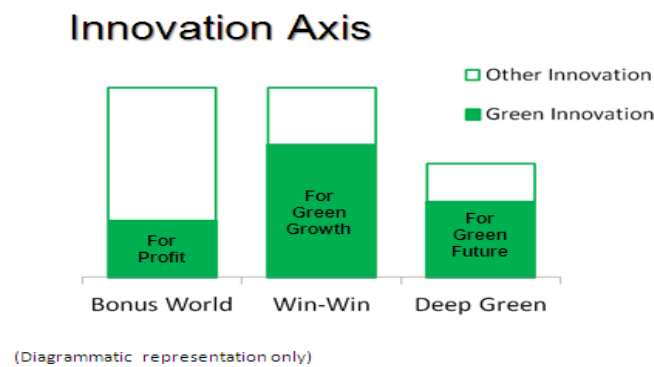


Table 1: Scenario axes

Scenario	Win – Win	Bonus World	Deep Green
Economic Growth	High	High	Low
Green Values	Strong	Weak	Strong
Rate of Innovation in Green Technologies	High	Medium -	Medium +

A brief overview of OSH conditions in each scenario is given in Table 2.

Table 2: Summary of OSH conditions in each scenario

	In Win-Win, a buoyant economy, funds are available for investment in safety, but the innovation proceeds at a high pace. The rapid roll-out of new technologies and new products, and the creation of new jobs requiring new skills means that a wider population faces new risks over shorter timescales. It is, therefore, important that OSH assessments are undertaken early in the development cycle of a technology or product so that the pace of development doesn't leave OSH behind.
	In Bonus World, a healthy economy, funds are available to invest in OSH and make infrastructure and business processes safe, but OSH is of relatively low importance to most governments. Employers see OSH as important in terms of its impact on profits. New jobs and new products may bring new hazards and the rapid roll-out of new technologies means that a wide population is exposed to these with short timescales for determining their possible health and safety impacts. OSH by regulation is more effective than OSH by education. As in Win-Win, there are skills shortages associated with the high pace of innovation. This leads to a polarisation of the workforce with regard to skills, with less-skilled workers more readily found in jobs with poorer, more hazardous working conditions.
	In Deep Green, low economic growth has tempted employers to cut corners, making investment in safer and healthier infrastructure more difficult. A tendency towards decentralised, more local and smaller enterprises (in particular microenterprises and self-employment) makes it more difficult to reach workplaces to disseminate good OSH practices and to control OSH conditions. With emphasis on reduced consumption of energy and physical goods, most new jobs are in the service sector. Many new small businesses, often with skills deficits, are set up to meet these needs. A make-do-and-mend approach leads to refurbishment rather than replacement, so there are risks associated with the use of old equipment. In this scenario, there are more difficult 'dirty' manual jobs (in repair, maintenance, waste sorting etc.) than in the other scenarios with more innovation and automation. But the relatively slow roll-out of some new technologies and products gives more time to assimilate new hazards and risks. There are many new green processes and enterprises, all of which require new OSH procedures and training.

More detailed summaries of each scenario are at Annex 3. Full details of the scenarios and the scenario building process are given in the project report ⁽²⁾.

² EU-OSHA — European Agency for Safety and Health at Work, *Green jobs and occupational safety and health: Foresight on new and emerging risks associated with new technologies by 2020*, 2013

<http://osha.europa.eu/en/publications/reports/green-jobs-foresight-new-emerging-risks-technologies/view>

3.1 Exercise 1 – Headlines exercise

This exercise was designed to give delegates some familiarity for the scenario with which they would be working. The delegates, in three groups – one for each scenario – were invited to read the short summary of their scenario (see Annex 3), to discuss potentially important OSH issues in the scenario and then to produce possible news headlines for 2020 to reflect their discussion. Each group fed back their findings to a plenary session. The headlines identified are shown in Table 3.

Table 3: Exercise 1 – scenario headlines

	<i>Win-Win</i> Group members thought that the speed of innovation would be a problem, with OSH constantly playing ‘catch-up’, but old risks would still be significant. Issues of responsibility and blame might also be important.
<i>Win-Win Headlines</i> • ‘Slips, trips and falls still a problem.’ • ‘Yet another allergen.’ • ‘Cancer scare over new material in daily use.’ • ‘Typhoon wipes out wind farm’, or • ‘Wind farm survives typhoon.’ • ‘XYZ corporation denies responsibility (again).’	
	<i>Bonus World</i> The high rate of innovation was also picked out by members of this group, as was responsibility for OSH. Employers were not so motivated towards OSH and inspection was necessary to ensure compliance. It is a high pressure world, with high levels of stress; automation adds to this, but can also help older workers and disabled workers and remove some physical risks. There is polarisation of the workforce between high and low skills. New materials could lead to long-latency diseases difficult to trace back to jobs.
<i>Bonus World Headlines</i> • ‘Employment rate hits new high!’ • ‘New drugs help you to work 24 hours.’ • ‘We are not just statistics – what about human values?!’ • ‘Where is the balance between private and working lives?’ • ‘New technology helps the disabled’ • ‘Latest riots a result of polarised workforce.’	

	<i>Deep Green</i> Group members saw decentralisation, bringing difficulties in monitoring and enforcing OSH in small companies, as important. This could mean lower OSH standards - a diverse workforce in diverse locations, with poor training levels, handling a range of new materials. There is little money for OSH, which comes second to environment. Old risks are still significant.
<i>Deep Green Headlines</i> • 'Keep your waste at home', say campaigners.' • 'Never mind the new risks; what about the old?' • 'Give us the right OSH training, say green workers (nobody listens to us).'	

4 Presentation of new and emerging OSH issues in green jobs identified in EU-OSHA's foresight project

Peter Ellwood (HSL) gave a presentation on a range of OSH issues identified during the Green Jobs project. A wide range of OSH issues for each technology and in each scenario is presented in the reports for the Green Jobs project. For the purposes of the workshop a smaller range of issues is discussed. Rather than consider them by technology, a range of common themes has been picked out. These are:

- *Decentralisation* of processes and workplaces into smaller, dispersed units and microenterprises, possibly with lower OSH awareness and culture, and fewer resources for OSH. There is likely to be difficulty in communicating and enforcing good OSH practice in dispersed workplaces. Examples include the renewable energy sectors with distributed, small-scale renewable energy installations which, especially when installed by new, unskilled entrants in the sector, are likely to be non-standard installations, hazardous to maintenance workers. Advanced manufacturing techniques, such as 3D printing, offer greater flexibility, possibly resulting in decentralised, local manufacturing with distributed hazards in small units and new groups of workers exposed to manufacturing risks. Mass customisation, with batch sizes of one, could also lead to product safety and OSH issues, where items are one-offs and OSH standards are difficult to define or enforce.
- *New materials* – a wide range of new and modified known materials is becoming available. For many of these the risks are unknown. Examples include nanomaterials, composites, biomaterials, ceramics, smart materials, quantum materials, metal organic frameworks and plastic electronics. The use of recycled or organic materials could also present OSH hazards. These will be present in a range of sectors, e.g. manufacturing, biotechnology, waste handling and construction.
- *Conflict between green and OSH* – where measures taken to protect the environment may adversely affect OSH. For example, time pressures from environmental grants and subsidies and their withdrawal can lead to work done in a hurry, with the potential for new entrants to appear, without the necessary skills, and could contribute to OSH being overlooked. Indoor finishing in construction work in energy-efficient, tightly-sealed buildings might expose workers to higher concentrations of dangerous substances. Increased pressure on recycling could increase risks in that sector and also in others. High waste-disposal charges could lead to more in-house efforts by

the waste producer to deal with waste, so risks linked to waste management may be transferred from professional waste operators to possibly unskilled waste producers.

- *Innovation and automation* – rapid progress in innovation could mean that OSH gets left behind. Increasing automation could mean that workers are removed from dangerous work. For example, off-site, automated construction of modular buildings is likely to improve on-site safety as construction moves into factories where good OSH conditions are easier to ensure. However, at the same time increasing complexity in processes and human machine interfaces, introduction of collaborative robots (co-bots) in manufacturing and over-reliance on computers, as in the case of driverless vehicles and platooning in transport, could introduce new risks.
- *Increasing reliance on electricity* – increasing use of electric or hybrid vehicles could bring new risks to maintenance workers and emergency services from high-voltage systems. Increasing use of electricity to heat buildings and connection to smart grids could bring risks to installers, maintenance workers and emergency services. As vehicle batteries that have reached the end of their life for vehicle service will be increasingly used to store electricity in buildings, as well as the “normal” fire and explosion risks associated with batteries, there may be the added complication of batteries that are degraded, decaying, unlabelled and of unknown provenance and design.
- *Other issues* – all these changes bring a need for new OSH knowledge and skills, but there may be skills shortages. This could bring about polarisation of the workforce – high skilled jobs versus precarious work. This may affect diversity in the workplace with fewer opportunities in high skilled green jobs for vulnerable groups.

4.1 Plenary discussion on OSH issues

Discussion following the OSH presentation focused on the use of the scenarios and potential targets for the outcomes of scenario studies rather than the OSH risks themselves. Topics discussed and comments made included:

- Scenario work can be used to inform policy makers.
- The scenarios produced as part of the Green Jobs project are not “static” final deliverables, but rather a tool to support further discussions. The scenarios could be modified to suit, for example, a particular country or a particular sector.
- Focal Points would welcome a presentation pack on the results of the project to take to their national governments.

4.2 Exercise 2 – What are the future OSH challenges and opportunities in each scenario?

In this exercise, working in their groups, delegates were asked to consider the OSH presentation and to discuss the OSH issues for green jobs in 2020 in their scenario. These could be existing OSH risks found in new combinations, involving different possibly unskilled workers’ groups, or that could be considerably changed, or be completely new.

They were then asked to select and agree the following:

- Two most important OSH opportunities in their scenario;
- Two most important OSH challenges in their scenario;
- One surprising OSH issue in their scenario.

Groups were each provided with a set of 27 cards describing OSH issues taken from the previous presentation on New and Emerging OSH issues in Green Jobs as an aide memoire (see Annex 4).

The challenges and opportunities identified in each scenario by the groups are shown in Tables 4-6 below.

Table 4: Challenges and opportunities – Win-Win

Opportunities and challenges – Win-Win	
	There is plenty of money available, more OSH training is provided in school to younger generations. The fast pace of innovation, particularly automation, enables people formerly classed as disabled and unable to work, to find employment. Automation reduces physical jobs, which can be more dangerous, and computer skills are needed. The fast pace of innovation also means that OSH is playing catch-up to the introduction of new technologies.
Challenge	There are psychosocial issues related to both the adaptation to the high rate of innovation and the lack of separation between work time and recreation (work-life balance), which is accentuated by the increasing pressure on people to work from home to save energy in the workplace.
Challenge	New materials and technologies increase and their potential risks are unknown. There is insufficient time given to research on the health and safety of materials and long-latency diseases take years to emerge and may be difficult to trace back to exposures.
Challenge	There is more sedentary work as a consequence of automation. There may also be earlier incidence of MSDs in younger workers as a consequence of the increased use (at a younger age) of ICT devices such as tablets, smart phones etc.
Opportunity	Better opportunities for people with disabilities to find work.
Opportunity	OSH is affordable.
Surprising	OSH is now seen as a barrier to innovation. The world cannot afford OSH regulation to slow down innovation, so OSH and regulation need to adapt. There is an increasing need for better and earlier cooperation with technical developers.

Table 5: Challenges and opportunities – Bonus World

Opportunities and challenges – Bonus World	
	The group saw this as a scenario of increasing OSH risks, owing to the profit motive combined with increasing rates of innovation and use of new materials. There would also be increasing interactions between workers and machines. It is difficult to convince employers of the need for OSH regulation and there is likely to be a tendency to cover up problems. Financial incentives are likely to be the most effective way to influence employers' attitudes to OSH.

Challenge	Polarisation of the workforce will increase and there will be more migrant workers. People will frequently change jobs and some will have multiple jobs, which will make it difficult to monitor workers' global burden of occupational exposures. The public sector will find it increasingly difficult to retain the necessary skilled workers.
Challenge	With the rapid introduction of new technologies and new materials, and low priority given to OSH by employers, OSH education and awareness for workers will be important. It will be necessary to convince workers of the importance of OSH so that they are empowered to look after their own interests. A cultural change is needed, which could start in kindergarten and continue throughout working life.
Opportunity	A key opportunity in 'bonus world' is the high level of innovation that could facilitate new technological measures to support OSH, such as automated shut down of hazardous machinery. The challenge would be to convince employers to exploit these opportunities.
Challenge and opportunity	Inspections will be required to achieve acceptable OSH standards but these will be difficult to deliver, owing to the difficulty in retaining the skills needed for inspectors and employers' attitudes. Technology, including remote monitoring, is likely to be one way achieving an acceptable minimum level of inspection.
Surprising	The group saw an increasing use of new types of drugs to increase performance in the workplace.
Surprising	It was also felt that this would be a 'big brother' society, with employers monitoring workers with advanced, sometimes invasive techniques, and inspectors remotely monitoring workplaces.

Table 6: Challenges and opportunities – Deep Green

Opportunities and challenges – Deep Green	
	The group initially found this scenario to be rather negative, but following discussion some positive features were identified, for example people working shorter hours and being less dependent on technology, for example mobile phones. This improves work life balance, with more emphasis on local production and less stress. It might be easier to deal with a diverse workforce in such a scenario, where there is an emphasis on local issues and on community. There is little money for OSH and for OSH training, leading to a shortage of people with the right skills. Growth of recycling and of maintenance and repair rather than replacement bring risks.

Challenge	OSH training; there is no budget to organise training, but trained people attract prestige so people are motivated to obtain training and may pay themselves.
Challenge	Maintenance is a source of accidents and lack of maintenance also brings risks as a result of malfunction or collapse. Materials are reused and workers are exposed to old risks, some of which may have been forgotten.
Challenge and opportunity	Migrant workers are identified as both a challenge and an opportunity. The challenge is linked to a possible lack of OSH knowledge and to their starting micro and SMEs, while an opportunity is identified in the increased focus on community and local issues that would give more opportunities to vulnerable groups to be better integrated.
Opportunity	With the emphasis on local issues and community, people start to slow down, to work shorter hours, rely less on technology and generally live healthier lives. This brings a reduction in stress, both at home and at work, and people have a positive attitude to OSH. The relaxed approach brings with it greater tolerance resulting in a positive attitude to diversity at work.
Surprising	Knowledge, including OSH knowledge, can disappear quickly. A non-OSH related anecdote given was the military using electronic guidance systems-aids who are unable to read maps any more when the equipment fails. An OSH example might be loss of awareness that old buildings or structures might still contain asbestos, for example Austrian workers exposed to asbestos during bridge maintenance works. The issue is how long information needs to be kept.

5 How can we shape the future towards better OSH in each scenario?

5.1 Exercise 3 – Policy options to address future OSH challenges

In this exercise, again working in their groups, delegates were asked to review the OSH issues they had identified in Exercise 2 and then to develop potential actions or policies to:

- Maximise opportunities;
- Mitigate challenges; and
- Deal with a surprising issue in their scenario.

The discussion should also consider implementation of the actions/policies. Actions and policies identified in each scenario are shown in Tables 7-9 below.

Table 7: Actions and policies – Win-Win

Actions and policies – Win-Win	
<i>Let OSH regulations enable (rather than hinder) innovation</i> • Introduce OSH assessment and testing at a very early stage. • Balance speed and safety; probably best to focus on good practices that are already taking place, rather than wait for legislative changes. Foster information exchange and transferability of these good practices. • No room for a strict precautionary principle.	
<i>OSH training in schools/Mainstreaming OSH into education</i> • Training in schools. • The role of education ministries is important; better cooperation between ministries would be needed. • Labour ministries could provide the input for education. • Improve awareness of future teachers. For example, when teaching electricity as a topic, teachers could include the avoidance of risks.	
<i>Separation of work and private life</i> • Implement awareness-raising campaigns about the importance of a good work-life balance to improve health. • Have a sector approach. • Target more especially employers with the message that workers should not always be on duty despite the technological advances that enable 24 hour shifts and ICT developments that allow 24 h working from anywhere. • Also, raise awareness among small and micro enterprises of the importance of a good work life balance.	

Table 8: Actions and policies – Bonus World

Actions and policies – Bonus World	
<i>New Independent Body for OSH</i> – In ‘Bonus World’ the unions and workers are very weak, governments do not have a mandate for OSH and companies are motivated by short term profits. The tri-partite arrangement will therefore not deliver an acceptable level of OSH. It was felt that a new independent body with national, European and international responsibilities would be required to address these failures. It would be funded through general taxation and an OSH levy on companies. In return, companies could be rewarded with tax breaks for good OSH performance.	

The responsibilities of the new body could include:

- OSH research programmes
- Sponsoring internationally agreed legislation and regulations
- Inspections and enforcement
- Manage financial incentives for good OSH
- Ensuring that an OSH plan is part of company registration
- Sponsoring OSH awareness campaigns in schools and workplaces

It was recognised that it would be difficult to launch such a new body but it was considered an essential requirement for acceptable levels of OSH to be achieved in the scenario.

Better cross-border legislation – greater consistency of OSH legislation across Europe, including corporate manslaughter legislation so that OSH enforcement is applied consistently across countries and OSH problems are not exported to other countries, for example waste materials for processing.

Random drugs tests – In order to address the major increase in performance enhancing drugs in the workplace a system of random drugs testing would be required. This would be an expansion of the testing that is currently undertaken in certain large companies and the armed services in many countries. However, this also raised issues of monitoring of workers and intrusion into health and private life issues with possible discrimination. Strong rules on privacy are needed to prevent such misuse. This testing could also be implemented and monitored by the independent OSH body mentioned above. Employers should not have access to health data.

Table 9: Actions and policies – Deep Green

Actions and policies – Deep Green	
<i>Merge responsibility for OSH and environment</i> - Given the shortage of funds available to pursue good OSH and since OSH takes second place to environmental matters in this world of high green values, one way to improve awareness of OSH and therefore improve it is to link OSH to environment. This could include, for example, environmental and OSH being covered by the same regulator. Implementation would rely on local communities, NGOs and volunteers.	
<i>Campaign focused on maintenance</i> – Since maintenance has been identified as a significant source of accidents in this scenario, a campaign focused on this area should be implemented. This could be low cost and in the spirit of a green society, for example using poster competitions and recycled old material. TV campaigns can be seen on communal TVs in community meeting places (maybe the pub...)	

Training – lack of training and lack of funds for training were identified as problems in Deep Green. Increasing the number of OSH trained workers by using the focus on local communities would be relatively low cost. Volunteers and NGOs would be important and would help with training. Large companies could support smaller companies, possibly motivated by tax incentives. Again, linking OSH to environmental activities could raise its profile.

5.2 Exercise 4 – Testing the ideas/actions/policies from Exercise 3 across the scenarios

Testing policies against a range of the scenarios is important, as the future is likely to contain elements of each scenario in a combination that cannot be anticipated. Such testing can help to identify which policies are robust enough to work in a range of different futures as opposed to those that will work in only one. In this way policies can be future-proofed. This process is often called ‘wind – tunnelling’.

This exercise was carried out in plenary session, but it can also be conducted through group exercises or a separate review by a policy team. Whatever the approach, care is needed to safeguard against preconceived views on both policies and the future. An open-minded approach will allow decision makers to consider and be prepared for the widest range of possibilities.

Each group was asked to report on two of the actions or policies considered for their scenario. Each group reviewed the policies generated in the other two scenarios, considering the following for their scenario:

- **Relevance** - is the policy addressing an issue that will be significant in their scenario?
- **Benefits** - is the policy effective given the conditions in their scenario? and
- **Implementation** - if a policy is potentially successful in their scenarios, would it be implemented in the same way?

On the basis of these criteria, the two policies from each scenario were tested across the three scenarios and ranked between +5 and -5.

The results of this exercise are as shown in Table 10:

Table 10: Wind tunnelling of actions and policies

<i>Policy</i>	<i>Ranking in Win-Win</i>	<i>Ranking in Bonus World</i>	<i>Ranking in Deep Green</i>
1. Early OSH assessment to allow innovation. Strengthened exchange of good practice and weakened precautionary principle (proposed by the Win-Win group).	+5	+2	+2
2. Mandatory workplace testing for performance enhancing drugs (proposed by the Bonus World group).	0	+5	0

Policy	Ranking in Win-Win	Ranking in Bonus World	Ranking in Deep Green
3. Merge OSH/Environment Authorities, Inspectorates, NGOs etc. (proposed by the Deep Green group).	+2	-4	+5
4. OSH training in schools (proposed by the Win-Win group).	+5	+5	+4
5. Independent OSH body (proposed by the Bonus World group).	+2	+5	-4
6. Campaign on maintenance issues (low cost, posters etc.) (proposed by the Deep Green group).	+3	+1	+5

It is important that decisions taken are not simply based on a scoring of policies against the scenarios. A low score does not necessarily mean that a policy should be discarded. A policy that initially appears to be scenario dependent might be valid in other scenarios if implemented in a different manner, or modified in some way. The process is used to facilitate cross scenario consideration of policies and if stakeholders are engaged in the process it can provide a good framework for facilitating a strategic discussion. During the plenary discussion the following conclusions were drawn on the six policies that were tested:

Policy 1. This was designed to meet the challenge in 'Win-Win' of high levels of rapid innovation in a scenario that saw OSH as important. The part of it relating to early consideration of OSH was broadly positive but less relevant to 'Deep Green' as the pace of innovation was slower. In the case of 'Bonus World' the early consideration of OSH was thought to be helpful, in view of the high rate of innovation, but the reduction of the precautionary principle would further weaken an already weak OSH situation.
Summary - despite having the same score of +2 in the other scenarios, the respective benefits and the positive aspects of the policy were different.

Policy 2. This addresses a particular issue of the use of cognitive drugs in the workplace in 'Bonus World.' This is not a significant issue in the other two scenarios, so is not a relevant policy. **Summary - this is an example of a scenario dependent policy, which is not negative in other scenarios**

There may be sound reasons why a policy that is contingent on a particular scenario should be implemented. In this case the analysis would be used to consider how the policy could be adapted to make more robust against other scenarios and to consider the risks associated with the policy.

Policy 3. This is designed to strengthen OSH by linking it to the strong 'green' values. In 'Bonus World' there are weak 'green' values so this would have a negative impact on OSH. In 'Win-Win' it would bring some limited benefits. **Summary - this is an example of how a policy that is a priority in one scenario can have a strong negative impact in another.**

If it were considered important to implement such a policy, the associated risks from a potential future in which the policy has a negative impact would need to be managed.

Policy 4. This has a positive impact in all three scenarios, although the implementation may vary. **Summary – this is a robust policy that will have strong benefits irrespective of the future scenario.**

Policy 5. This addresses the failure of the tri-partite system to deliver OSH in 'Bonus World.' It would be neither practical nor beneficial in 'Deep Green' and would be of limited benefit in 'Win-Win.' **Summary – this is an example of how a new initiative can have either positive or negative impacts depending on the future scenario.**

Policy 6. This deals with an aspect of 'Deep Green' but it would be implemented differently in 'Win-Win' and would be redundant in 'Bonus World.' **Summary – this is a scenario dependent policy but its implementation is low risk as it does not have negative impacts in other scenarios.**

6 Conclusion

The Focal points were successfully taken through the process of identifying potential future OSH issues and of formulating policies and actions to deal with them. The ‘wind tunnelling’ of the above policies demonstrated how different policies perform against different potential futures. The future of ‘green jobs’ is likely to contain elements of all the three scenarios.

Scenarios are a potentially powerful tool, which can be used to assist in the development and testing of policies, and while they do not remove the uncertainty of the future, they should lead to the consideration of a broader range of policies and a better understanding of the respective risks.

Of course, this workshop, while it served to demonstrate the scenario process, did not allow sufficient time to undertake a thorough policy identification process. Much more time would be needed to investigate the issues in more detail.

During the concluding plenary discussion Focal Points were mostly positive about their experiences in the workshop. When asked whether the discussions they had had during the workshop were different from usual types of discussions they have, about two thirds raised their hands.

Comments made in discussion included:

‘I was quite sceptical at the beginning of the workshop, but this is a good approach that makes you think. It would be nice to organise a similar workshop at one of our national events.’

‘Interesting to use’

“It offers the possibility to be more creative than in usual meetings dealing with problems. It opens your mind, a good tool to be creative.”

“This approach should be applied more broadly in order to give everybody a new vision and perspective. We were all very sceptical about it at the beginning and now we are all very positive.”

“Excellent, I really enjoyed it. Thank you very much.”

‘The project should be enlarged. It gives a new vision. I was sceptical, but am now positive about it after two days.’

‘Decision makers should be involved in this type of discussion.’

But not everyone was convinced, with some comments ranging from cautious to rather doubtful.

“I found it difficult to identify with the Deep Green scenario; this is not realistic, but the methodology makes you think about different issues, it helps to broaden your perspective.”

“I find difficult to identify myself with the Deep Green scenario and difficult to understand the enthusiasm of my colleagues for a romantic view of the scenario. After two days I am even less convinced that this Deep Green is a good thing, and even less understanding of why my colleagues are now so enthusiastic.”

“Can this influence governments on OSH?”

'A good process, but dangerous in the hands of top people? Politicians think they have more power to influence the future than they really do.'

However, it is important to have people with a range of views in such a process as different views make for fruitful discussions. The key benefits of using scenarios are that they challenge mind-sets and should open up consideration of a wider range of options. The scenarios are a tool to support decision making; but the value comes from the strategic discussion they generate and the insights gained. (See *Scenarios: The Art of Strategic Conversation*) ⁽³⁾.

Other participants were cautious at the start of the workshop, but became more positive during the course of the proceedings.

"In the beginning we were very sceptical. Now we are optimists."

Overall, the comments made and the lively atmosphere of the workshop showed that delegates had understood the nature of scenario work and its applications and would return to their home countries sufficiently enthused to be advocates for the scenario approach. Some Focal Points even suggested that this approach should be more widely used in their Focal Point meetings.

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³ Scenarios: The Art of Strategic Conversation, Kees van der Heijden (2004), Wiley, ISBN: 978-0-470-02368-6

Annex 1: Agenda

Meeting:	Foresight workshop for EU-OSHA Focal Points on new and emerging risks associated with new technologies in green jobs	
Date:	12/11/2013	13/11/2013
Time:	14:30 – 18:30	09:00 – 13:00
Place:	Bilbao, Gran Via 35, 7 th floor, meeting room Inbisa A	
Participants:	EU-OSHA Focal Points	

▪ 12 November

- 14.30** Welcome and Introduction to project (Emmanuelle Brun, EU-OSHA)
- 14.40** Workshop introduction (John Reynold, SAMI Consulting)
- 14.50** Group discussion of priorities for workshop
- 15.10** Feedback
- 15.30** Presentation on how foresight and scenarios can support policy-making; and introduction to the EU-OSHA's scenarios. (John Reynolds)
- 16.15** Exercise 1 - Initial exercise to study the allocated scenario and consider potential OSH headlines for 2020. (The Focal Points will be divided in 3 groups and allocated to one of EU-OSHA's scenarios for all the workshop group exercises)
- 16.45** *Break*
- 17.00** Feedback of headlines and discussion of the scenarios
- 17.20** Presentation of the new & emerging OSH issues in green jobs identified in EU-OSHA's foresight project (Peter Ellwood, HSL)
- 18.00** Plenary discussion
- 18.30** Close

▪ **13 November**

09.00 Introduction to Day 2

09.10 Exercise 2 – What are the future OSH challenges and opportunities in each scenario?
(Group work)

10.00 Feedback and plenary discussion

10.30 Exercise 3 – How can we shape the future towards better OSH in each scenario?
Actions/policies to achieve best OSH outcome (taking into account the respective
challenges and opportunities from Exercise 2) (Group work)

11.30 *Break*

11.45 Exercise 4 – Testing the ideas actions/policies from Exercise 3 across the scenarios

12.45 Concluding discussion of the contribution the scenarios can make to the analysis of future
OSH issues, strategic thinking and policy-making

13.00 Close

Annex 2: Workshop Attendees

Foresight Workshop on New Technology and Green Jobs



Bilbao, 12-13 November 2013

Name	Organisation	Country
Katalin BALOGH	National Labour Office	Hungary
Eduard BRUNNER	State Secretariat for Economic Affairs (SECO)	Switzerland
Kaarre DOMAAS	Norwegian Labour Inspection Authority	Norway
Martin DUCKWORTH	Sami Consulting Ltd	United Kingdom
Peter ELLWOOD	Health and Safety Laboratory	United Kingdom
Fatma Gulay GEDIKLI	Ministry of Labour and Social Security, Directorate General of OSH	Turkey
Trosima GJINO	State Labour Inspectorate	Albania
Aneta GRANDA	National Research Institute	Poland
Francesca GROSSO	INAIL (National Institute for Workers' Compensation)	Italy
Martina HAECKEL-BUCHER	Federal Ministry of Labour, Social Affairs and Consumer Protection	Austria
Liisa HAKALA	Ministry of Social Affairs and Health	Finland
Ioannis KONSTANTAKOPOULOS	Ministry of Employment and Social Protection	Greece
Wioleta KLIMASZEWSKA	Central Institute for Labour Protection	Poland
Ljupcho KOCHOVSKI	Macedonian Occupational Safety and Health Association	Macedonia
Vladka KOMEL	Ministry of Labour, Family, Social Affairs and Equal Opportunities	Slovenia
Miodrag LONCOVIC	Ministry of Employment and Social Policy	Serbia

Attendance list

Name	Organisation	Country
Gavin LONERGAN	Health and Safety Authority	Ireland
Linda MATISANE	State Labour Inspectorate	Latvia
Agim MILLAKU	Ministry of Labour and Social Welfare - Labour Inspectorate	Kosovo
Eleni NAOUM LOIZIDOU	Department of Labour Inspection	Cyprus
Georgiana NICOLESCU	INCDPM (National Research & Development Institute on Occupational Safety 'Alexandru Darabont')	Romania
Belen PEREZ-AZNAR	INSHT (National Institute for Safety and Health at Work)	Spain
Alain PIETTE	Federal Public Service Employment, Labour and Social Dialogue	Belgium
Kristel PLANGI	Labour Inspectorate	Estonia
John REYNOLDS	Sami Consulting Ltd	United Kingdom
Henk SCHRAMA	TNO Work & Employment	Netherlands
John SCHNEIDER	Inspection du travail et des mines	Luxembourg
Boglarka BOLA	European Agency for Safety and Health at Work	EU-OSHA
Emmanuelle BRUN	European Agency for Safety and Health at Work	EU-OSHA
Xabier IRASTORZA	European Agency for Safety and Health at Work	EU-OSHA
Katalin SAS	European Agency for Safety and Health at Work	EU-OSHA
Michaela SEIFERT	European Agency for Safety and Health at Work	EU-OSHA
Monica VEGA	European Agency for Safety and Health at Work	EU-OSHA

Scenario Summaries

Win-Win**High economic growth**

Looking back from 2025, after a slow start in 2012, growth across the EU and OECD returned to the levels prior to the economic crash of 2008. Developing countries also experienced high growth similar to that in the first decade of the century.

High green values

Advances in climate science started to show how vulnerable we are becoming to climate change. Growing public concerns encouraged governments to introduce green policies, including those leading to deep and progressive cuts in carbon emissions.

There was strong approval for green behaviour by corporations and individuals. This was reinforced by concerns over resource shortages (food, commodities, minerals, water and energy.)

High level of innovation in green technologies

Green growth has increasingly been seen as vital for a sustainable future. Corporate profits and access to finance have supported high levels of investment in new business opportunities and infrastructure. The rate of technological developments has accelerated with high levels of innovation. A high proportion of the innovation has been aimed at achieving a green outcome and generating future profits.

Society and work

Most people in the EU now feel prosperous and place a higher value on the preservation of the environment, human life and well-being. The strong economy allows governments to address the increasing demands for welfare and to invest in education.

There is high employment and many new jobs and new products are now being created over ever-shorter timescales, which can lead to new hazards and risks if not designed with OSH taken into consideration.

Occupational safety and health*Overview*

In a buoyant economy, funds are available for investment in safety, but the high pace of innovation and the rapid roll-out of new technologies and new products, and the creation of new jobs requiring new skills mean that a wider population faces new risks over shorter timescales. It is, therefore, important that OSH assessments are undertaken early in the development cycle of a technology or product so that the pace of development doesn't leave OSH behind.

Wind energy

The risks are multiplied many fold in offshore wind farms, which have the potential to become very dangerous worksites. With so many large turbines in ever-deeper water, ever further from safe haven, access issues are the dominant OSH consideration. Working sites are more widely dispersed, with lower profit margins to pay for safety than in the oil and gas industries. Construction is hazardous and with the large numbers of turbines come skill shortages as wind competes with other technologies for qualified staff. Specialist vessels are required to handle large turbines in deep water, and there are still issues over foundation strategies (especially as the seabed is different for each turbine in a wind farm), transport of foundations from yards, and longer-term issues over removal of foundations. Novel turbine designs have brought engineering unknowns. In the hostile environment, maintenance is demanding, although more reliable electronic infrastructure monitoring devices help to minimise unpredicted maintenance and improved quality of equipment has helped reliability. The need for workers to live so far offshore is leading to work organisation issues and psychosocial problems. New composites and nanomaterials used for the manufacture of wind turbines have possibly introduced new health hazards for workers involved in manufacturing, maintenance, decommissioning and recycling.

Green construction and building retrofitting

Off-site automated construction of modular buildings has improved on-site safety as far fewer tasks are undertaken on site. However, as building moves into factories, new risks emerge as workers are exposed to novel substances increasingly used in construction material (e.g. phase change materials, heat storage chemicals, novel surface coatings, nanomaterials and fibrous composites).

On-site issues arise from mixing automated with traditional, manual activities. There are risks during the connection of services (e.g. water and electricity) to prefabricated modules but, with the correct design, these should be negligible. There are also electrical risks as old and new buildings have to be integrated into the smart grid, incorporating smart appliances, energy storage technologies, etc. In increasingly crowded cities, the trend of developing basements has led to increasing underground congestion with associated OSH implications.

Scenario Summaries

due to working in confined spaces, the risk of collapsing structures or drilling into existing cabling.

Combinations of new energy sources in buildings (e.g. photovoltaics (PV), geothermal and biomass) bring new hazards and unexpected accidents — in particular as there are many new players entering the sector.

With a high level of new build, there is a large quantity of old building materials from demolition to deal with, exposing workers to hazards. Retrofitting of existing buildings exposes workers to increasing roof work as they install solar panels and small-scale wind turbines, with the risk of falls and exposure to lead and asbestos as they disturb old structures.

Bioenergy

The storage and handling of biomass expose workers to physical, chemical and biological risks and to risks from fire and explosion. High temperatures, and sometimes high pressures, are used in pyrolysis (350–550 °C) and gasification (over 700 °C). There is also a potential issue with the increased variability in the constitution of gas derived from biomass compared to fossil fuels. Third-generation biofuels have the potential to give rise to new biological risks. There may also be operational risks associated with the scaling-up of third-generation biofuel production from demonstration plant to commercial scale.

With the widespread adoption of bioenergy, many workers are potentially at risk. Agriculture increasingly turns to biomass production and work in forestry is likely to intensify. Waste products from biomass can be toxic (e.g. wood ash contains heavy metals and is strongly alkaline).

Waste management and recycling

The political pressure to recycle means that workers are potentially exposed to a very large range of materials: increasing volumes of waste result in difficulties in identifying the provenance and composition of waste. However, improvements in labelling, tracking and auditing of materials are helping in the identification process.

Workers have to deal with hazardous waste, not just valuable waste, including material from urban mining and recycling of industrial waste. Nanomaterials are also increasingly appearing in waste as their use in manufacturing becomes more widespread. However, the increasing use of robots to sort and handle waste helps improve workers' health and safety.

The zero-waste economy entails dealing with the most difficult tail end of the waste stream: such wastes in concentrated form are hazards that need special handling.

Green transport

Maintenance of complex networks coupled with skills shortages presents an important OSH challenge. Most new vehicles are electric or hybrid. Rapid recharging or battery swaps may present hazards, as will the maintenance of electrified vehicles (EV). As electric vehicles are increasingly maintained by independent garages rather than specialists, there are electrocution risks since workers are not familiar with the high voltages involved. Risks of fire or explosion are particularly high during quick charging of EV and after accidents. Driverless vehicles and platooning (the grouping of vehicles that behave effectively as one) have improved safety for those who travel as part of their work. However, there is a risk of over-reliance on the technology. Absolute reliability is therefore crucial, with fail-safe modes in the event of accidents, problems or failures.

Green manufacturing, robotics and automation

Increased automation has improved OSH, in some respects, by removing workers from some hazardous tasks but, at the same time, the growth in the use of collaborative uncaged robots has introduced other potential risks.

Growing complexity and increasing ICT in automated manufacturing has brought human-machine interface issues. Some types of robot malfunction may be difficult to detect until it is too late and may, therefore, put workers' safety at risk. Growth in 'just-in-time' and 'lean' approaches facilitated by flexible manufacturing systems have put additional pressure on workers, leading to psychological risks. Workers are resorting to enhancement technologies in order to keep pace with developments and with their colleagues as well as with robots. There are potential unknown long-term health effects of new green materials and nanocomposites with a lower carbon footprint.

Domestic and small-scale renewable energy

The speed and diversity of change has resulted in skill shortages and, therefore, competency issues for work in renewable energy technologies. There are many new energy technologies where specific knowledge is needed but has not yet been fully developed, and where 'old' OSH knowledge and safe working practices are not always directly transferable. New entrants to the industry are not always sufficiently familiar with the risks and new combinations thereof. Small and medium-sized enterprises (SMEs) are increasingly using their land to produce electricity as a sideline and may use their own workers, or subcontractors, to install or maintain their renewable energy systems

Scenario Summaries

ad hoc, although such workers are not skilled in this type of work. The increasing adoption of solar PV has introduced risks for emergency workers accessing roof spaces that remain live even after the mains supply has been cut.

Batteries and energy storage

Hydrogen has grown in popularity as an energy carrier, including its use as a fuel for vehicles, bringing transport and storage issues. Batteries are the main means of electricity storage, with potential risks of fire and explosion, exposure to hazardous chemicals and electrocution from high voltages. Based on their experience from lead-acid batteries, people generally have a false perception that new batteries are safe. As for large offshore installations, specific OSH regulation is in place for deep-sea energy storage, which, although a

relatively low-tech concept, involves high voltages and power levels in a complex environment, complicating installation and maintenance work.

Energy transmission and distribution

The complexity of the SuperSmart Grid (SSG) makes it difficult to maintain top-down control of the grid and, consequently, of related OSH issues. The key OSH risk arises from increased live working to cope with the rapid pace of change. The dangers from electric shock, burns, fire and explosion are well known, but now involve different people in different situations. The increase in electricity storage is an added dimension. The pressure of work can lead to the use of inexperienced staff.

Scenario Summaries

Bonus World**High economic growth**

Looking back from 2025, after a slow start in 2012, growth across the EU and OECD returned to the levels prior to the economic crash of 2008. Developing countries also experienced high growth similar to that of the first decade of the century. High growth has led to high prices for natural resources, including energy.

Weak green values

After 2012, economic growth was the priority and some environmental degradation was considered to be an unavoidable consequence of strengthening EU economies. When faced with the costs, people have not valued greenness sufficiently for governments or business to have an incentive to deliver it. Government support for green practices is limited to charging for the visible externalities of production (noise, pollution, landfill, traffic congestion, etc.).

Medium levels of innovation in green technologies (directed towards profits)

Most consumers and businesses choose green products and services only if they are better or cheaper than the alternatives. Innovations in green technologies are limited to those areas that show a positive financial return.

High total levels of innovation

There are continuing advances in technology that are adopted into new products and processes. High levels of capital investment mean that capital-intensive technologies can be rolled out quickly. Corporate profitability and access to finance have supported high levels of investment in infrastructure. The environmental consequences of increased use of resources are seen as acceptable and necessary.

Energy sciences continue to deliver improvements in efficiency and low-carbon energy, but it is now clear that serious and unacceptable compromises would be needed to achieve a zero-carbon future.

Society and work

Most people in the EU now feel more prosperous than in 2012. They value economic well-being more than the environment, but are

prepared to pay for a pleasant environment in the vicinity where they live.

Businesses are focused on generating current and future profits. New jobs are being introduced at a relatively fast rate and there are high levels of employment. There is also high mobility of workers, while inequalities mean that low-skilled workers are readily exploited.

Higher income levels and corporate profits have provided the tax revenues that allow European governments to pay for sustainable welfare programmes.

Human performance-enhancing drugs are being routinely used in work settings.

Occupational safety and health*Overview*

In a healthy economy, funds are available to invest in OSH and make infrastructure and business processes safe, but OSH is of relatively low importance to most governments. Employers see OSH as important in terms of its impact on profits.

New jobs and new products may bring new hazards and the rapid roll-out of new technologies means that a wide population is exposed to these with short timescales for determining their possible health and safety impacts.

OSH by regulation is more effective than OSH by education.

As in Win-Win, there are skills shortages associated with the high pace of innovation. This leads to a polarisation of the workforce with regard to skills, with less-skilled workers more readily found in jobs with poorer, more hazardous working conditions.

Wind energy

With smaller turbines, predominantly located onshore, construction and maintenance are not as hazardous as in the other two scenarios; however, the proximity to population centres brings potential risks to a larger population, including workers. Much of the maintenance work is contracted out, so it is more difficult to keep an eye on work organisation and there is a risk of passing of blame and no due diligence by the ultimate owner. Cost pressures may lead to increased risk-taking. Many of the workers are migrants with low skill levels and a

Scenario Summaries

poor OSH culture. The decommissioning of old wind farms that were not designed to enable safe dismantling puts workers at high risk. New composites and nanomaterials used in the manufacture of wind turbines have possibly introduced new health hazards for workers in manufacturing, maintenance, decommissioning and recycling. On the plus side, the use of standardised designs has reduced complexity and made maintenance more straightforward.

Green construction and building retrofitting

Off-site automated construction of modular buildings has improved on-site safety as far fewer tasks are undertaken on site. There are risks during the connection of services (e.g. water and electricity) to prefabricated modules but, with correct designs, these should be negligible. However, as building moves into factories, new risks emerge as workers are exposed to novel substances.

On site, there are electrical risks as old and new buildings have to be integrated into the smart grid, incorporating smart appliances, energy storage technologies, etc. In increasingly crowded cities, the trend of developing basements has led to increasing underground congestion.

With a high level of new build, there is a large quantity of building materials from demolition to deal with. Compared with Win-Win, newer buildings are being demolished – exposing workers to new hazards from modern materials. Demolition waste is sent to landfill rather than recycling. Retrofitting of existing buildings exposes workers to increasing roof work as they install solar panels after they became economically viable, with the risk of falls and exposure to lead and asbestos as they disturb old structures. The lack of adequate ventilation when retrofitting insulation has become an issue, as this type of work may attract construction workers who are used to outdoor work and, hence, not aware of the need for proper indoor ventilation.

Bioenergy

As with Win-Win, storage and handling of biomass exposes workers to physical risks, to chemical and biological risks, and risks from fire and explosion: these may be mitigated by automation. Even where biomass is handled automatically, the boilers it fuels are a source of smoke and dust. With small subcontractors working under price pressures, work has intensified with a resulting increase in risks. Third-generation biofuels produced from organisms created by synthetic biology are a potential source of biological risks.

Waste management and recycling

With a high level of innovation, but a lack of attention to recyclability, the waste-handling process can be dangerous. There is some use of

automation for handling waste, but only where it is cheaper, rather than for OSH considerations. The rapid rate of innovation means that new materials appear and find their way into waste before OSH can be considered. This is a throwaway society, so a high number of workers are involved in handling waste and are, therefore, potentially exposed. In an increasingly complex world driven by profit, combined exposure can be an issue. High charges for waste disposal may lead to more in-house efforts by the waste producer to deal with waste, transferring risks from professional waste operators to the waste producer: for example, business owners (including microenterprises and SMEs, as well as private individuals) using small-scale digesters, waste compactors or incinerators.

Green transport

As with Win-Win, maintenance and recharging of electric vehicles have become important hazards as they have become increasingly widespread and work has moved away from specialist suppliers and maintainers to independents. The risks arising from the growth in electric vehicles is not confined to the vehicle itself. Vehicle batteries that have reached the end of their life for vehicle service are being used to store electricity in buildings. As well as the normal fire and explosion risks associated with batteries, there is, therefore, the added complication of batteries used for energy storage that are degraded, decaying, unlabelled and of unknown provenance and design. Automation of vehicles is proving to be positive for the OSH of drivers, although there is an issue of over-reliance on the technology. The technology needs to be absolutely reliable with fail-safe modes in case of incidents.

Green manufacturing, robotics and automation

As in Win-Win, increased automation has improved OSH by removing workers from some hazardous tasks. At the same time, the growth in the use of collaborative robots has introduced other potential risks. Increasing complexity and increasing use of ICT in automated manufacturing has brought human-machine interface issues. Safety (as opposed to health) is increasingly engineered into processes, driven by the desire to avoid lost production, while employers are less interested in longer-term health issues. Decentralised manufacturing systems such as 3D printing or other rapid manufacturing techniques can lead to new groups of workers being exposed to manufacturing hazards (e.g. harmful dusts, chemicals or laser light) yet not being adequately trained to deal with them. There may be new occupational diseases caused by exposure to new materials. Without exposure registers, diseases are difficult to trace back to jobs as no one stays on the same production line for their entire career any more.

Domestic and small-scale renewable energy

Scenario Summaries

In the period before solar PV reached grid parity, the sudden withdrawal of subsidies led to panic in the rush to meet deadlines, resulting in work done in a hurry thus introducing OSH risks including work-related psychosocial risks. The use of cheaper imported products, sometimes of poorer quality or even counterfeit, has led to increased risks, especially when installation is carried out by new entrants to the sector or by householders themselves.

Batteries and energy storage

Novel battery designs continue to appear, bringing potential risks from chemicals, carcinogenic metals, dusts, fibres, nanomaterials and fire. The waste treatment of batteries raises issues around recycling, degradation and fire risk. It is challenging to determine the precise contents of any particular battery type as this information is often treated as a trade secret. Batteries used as building energy stores are a hazard as people don't recognise the risks of overcharging. Hydrogen is used as an energy carrier but it is difficult to handle and there are risks of fire and explosion and risks from its cryogenic liquid form.

Energy transmission and distribution

There are risks from power cuts as cost pressures have led to a reduction in spare generating capacity. The risks arise from sudden darkness and the loss of power, especially with moving machinery, and other safety-critical situations. The pressure to squeeze more capacity out of the system leads to novel solutions, but this reduces safety margins. Substitution of copper cabling with aluminium, again driven by cost as copper becomes increasingly expensive, has introduced an increased risk of sparking and joint failure.

Scenario Summaries

Deep Green

Low economic growth

Since 2012, there has been little economic growth within the EU and some countries are still facing sovereign debt problems. The BRICs have not returned to the former high growth rates and are currently growing at about 5 % per annum. Other developing countries are growing at a rate broadly in line with the growth of their populations.

Strongly green values

Green values have strengthened over the last decade and there is widespread and strong approval for green behaviour by corporations and individuals. This has given governments a mandate to legislate for deep and progressive cuts in carbon emissions. Reduced growth is seen as a price worth paying for a green future.

Advances in climate science have shown just how vulnerable the human race will be to climate change. There are growing public concerns about the loss of ecosystems and resource shortages.

Medium innovation in green technologies (directed toward greenness)

The concerns about a green future have driven progress on improvements in efficiency and the target of a zero-carbon future. There are continuing advances in technology, but restricted levels of capital investment mean that capital-intensive technologies have been slow to be rolled out. Commercial success depends on having appropriately green products and services. There have been significant local small-scale innovations to address green issues, many directed toward self-reliance.

Energy sciences continue to deliver improvements in efficiency and low-carbon energy, but it is clear that serious compromises will need to be made to achieve a zero-carbon future.

Medium total innovation

The priority has been to direct innovation towards achieving a green future.

Society and work

Over the last decade, the key priority has been to move towards a green future, at the expense of growth and other social objectives. As a result, there is now higher unemployment and lower corporate profits. The reduced tax base has restricted the ability of EU governments to pay for increasing welfare demands.

The greening of the economy and society has introduced many new processes and enterprises, creating new green jobs. Businesses are focused on survival and reducing costs, and workers are concerned about joining the significant number of the unemployed.

Innovation continues to deliver improvements in efficiency and reduced carbon outputs but it is clear that serious compromises need to be made to achieve a zero-carbon future. Despite the difficulties, a green future is generally seen as worth the sacrifices.

Occupational safety and health

Overview

Low economic growth has tempted employers to cut corners, making investment in safer and healthier infrastructure more difficult. A tendency towards decentralised, more local and smaller enterprises (in particular microenterprises and self-employment) makes it more difficult to reach workplaces to disseminate good OSH practices and to control OSH conditions. With emphasis on reduced consumption of energy and physical goods, most new jobs are in the service sector. Many new small businesses, often with skills deficits, are set up to meet these needs. A make-do-and-mend approach leads to refurbishment rather than replacement, so there are risks associated with the use of old equipment. In this scenario, there are more difficult 'dirty' manual jobs (in repair, maintenance, waste sorting, etc.) than in the other scenarios with more innovation and automation. But the relatively slow roll-out of some new technologies and products gives more time to assimilate new hazards and risks. There are many new green processes and enterprises, all of which require new OSH procedures and training.

Wind energy

End-of-life issues and maintenance are the key OSH considerations. The economy requires the upkeep of older installations and there is pressure to keep systems running whatever the weather. Older wind turbines have not been upgraded with safety or ergonomic features, such as lifts, because of cost pressures: as a result, the physical risks associated with climbing and working in towers has become significant, especially as increasing numbers of older workers are unable to retire.

Scenario Summaries

Green construction and building retrofitting

With relatively little new build, the main risks to workers come from exposure to new materials during refurbishment and the handling of waste from refurbishment (including asbestos), and from the retrofitting of renewable energy technologies, involving work at height and electrical connections to the grid. Retrofitting also exposes workers to dust and hazardous chemicals. The lack of adequate ventilation may be an issue, in particular as this type of work may attract unskilled workers, including 'do-it-yourself' installers, unaware of the risks.

Bioenergy

The risks from fire and explosion and exposure to chemicals and biohazards are similar to those in the other scenarios, but the emphasis on local production and use — with many small-scale producers — creates risks that are more difficult to regulate. New players, less familiar with the risks of handling fuel (e.g. farmers producing low quantities, or companies starting to use their own waste as an energy source, for example in the textile or food industry) may be particularly at risk. There may also be problems with the quality of their products and, therefore, safety issues, as well as the impact on gas network pipelines from biogas or syngas not meeting the required gas specification.

Waste management and recycling

Overall, waste volumes are down as a result of strong green values and the economic situation, but there is still legacy waste to deal with and construction waste volumes from refurbishment are high. There is an emphasis on local handling of waste at the small-scale — meaning a potentially weaker culture of OSH and more difficulties in controlling OSH risks in a decentralised system — and there is a high manual component, with a relatively low level of automation. The quality of the waste stream has improved, but landfill mining is increasing as the costs of raw materials climb, so workers risk being exposed to safety hazards as well as unknown health hazards. Greater use of biomass in this scenario brings exposure to dust, allergens and other toxins. Reused items may compromise safety and health (e.g. steel made from recycled metals containing lead).

Green transport

As in Win-Win and Bonus World, the maintenance and charging of electric vehicles are key OSH concerns. However, driven by the need to economise and by strong green values, there has been an increase in two-wheeled vehicles for personal transport and goods as well as for service deliveries, exposing those who travel for their work to risk of injury and accidents. Many 'mobility self-entrepreneurs' have seen a job opportunity in this growing area of the transport sector. However,

the self-employed tend to have less of a culture of OSH and less access to OSH services such as OSH medical surveillance, labour inspectorate services; in addition, they are generally not covered by worker protection legislation.

Green manufacturing, robotics and automation

There has been less adoption of automation than in the other scenarios, so old OSH issues may persist as manufacturers make do with ageing infrastructure and machinery. The increasing tendency to outsource maintenance services to small companies has increased risks to maintenance workers who have to deal with a wide range of equipment to extend its life. The intermittent nature of renewable energy (reliant as it is on wind and sunlight, for example) means that shift working has increased, resulting in increased health and psychosocial issues and other risks such as accidents. Exposure to new materials in SMEs and microenterprises involved in decentralised manufacture (e.g. 3D printing) has brought potential exposure risks to more workers. Process integration means that industrial processes previously performed in different locations (e.g. manufacturing and recycling) are brought together, increasing the range of risks on a single site. This requires new skills and technical knowledge. However, there is a lack of skills as manufacturing is brought back into the EU as a result of global changes, and the loss of corporate memory and experience is exposing new workers to risks.

Domestic and small-scale renewable energy

A diversity of distribution systems and non-standard installations is resulting in electrical risks to maintenance workers. The combination of technologies (e.g. combined heat and power (CHP) and solar thermal) is adding to the complexity and, therefore, the risk. Similarly, unsophisticated, perhaps do-it-yourself, domestic installations are also potentially hazardous. Small-scale bioenergy generation gives rise to risks of fire and explosion and exposure to toxic substances. Distributed supply, especially from small clusters of houses or small businesses, is difficult to regulate. The emergency services are at risk when they attend non-standard installations. Emerging technologies generally may be responsible for long-latency effects, yet to emerge.

Batteries and energy storage

Batteries give rise to electrical risks and risks from toxic chemicals and fire. Greener batteries may be more hazardous as environmental regulations limit the range of materials allowed. Interconnected mixtures of energy storage technologies devices, especially those assembled by do-it-yourself enthusiasts, bring unexpected risks in themselves, to maintenance workers and to the emergency services. Hydrogen is used for energy storage, introducing risks of fire and explosion and risks from its cryogenic liquid form.

Scenario Summaries

Energy transmission and distribution

OSH issues include the difficulty in maintaining top-down control of the grid as distributed generating sources increase. Major work to upgrade the grid has been undertaken, introducing increased live working. Life-extended systems bring more risks than new systems. Biogas distribution has brought risks of intoxication, suffocation, explosion and quality issues

OSH Cards for Exercise 2

 FORESIGHT OF NEW AND EMERGING RISKS TO OCCUPATIONAL SAFETY AND HEALTH ASSOCIATED WITH NEW TECHNOLOGIES IN GREEN JOBS BY 2020 OSH SUMMARY CARDS FOR FOCAL POINT WORKSHOP BILBAO, 12-13 NOVEMBER 2013 Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 0	 DECENTRALISATION Decentralisation of workplaces into smaller, dispersed units, including rise of sub-contracted work, self-employed and micro-enterprises. Lower OSH awareness/culture and fewer resources for OSH. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 1
 DECENTRALISATION Decentralisation of workplaces into smaller, dispersed units Difficulty enforcing good OSH conditions and safe working practices in dispersed and difficult to reach workplaces with poorer access to OSH services (labour inspection, preventive services, training, etc.). Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 2	 DECENTRALISATION Decentralised manufacturing: • Dispersed locations, • Mass customisation, • Difficult to define and enforce standards for safe work as products are one-offs • Integrity of products, • Widespread storage and use of a variety of chemicals for a variety of one-off products, • Inexperienced workforces. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 3
 DECENTRALISATION Decentralised renewable energy generation • Distributed, small scale installations • Non-standard installations: risks to maintenance workers • New entrants without necessary skills • Sub-contracting • PV risks to installers • PV risks to fire services Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 4	 DECENTRALISATION Retrofitting of old buildings with renewables modules and/or energy efficiency measures Exposure to dust, lead, asbestos, MMMF, isocyanates, work at height, etc. – risks not new but in new situations Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 5
 NEW MATERIALS A range of new materials presenting (unknown) risks, possibly causing new long-latency work-related diseases affecting several sectors. Difficulty in tracing diseases back to jobs without exposure registers, since no-one stays in the same job for life. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 6	 NEW MATERIALS Green construction materials, including new materials (e.g. phase changing materials, new insulation etc.) with potential chemical exposures, organic materials, (bamboo, straw, sheep wool) and recycled materials. Close handling and long exposures. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 7

OSH Cards for Exercise 2

   NEW MATERIALS Safety of third-generation biofuels and any side products and contaminants. Biohazards from new organisms and synthetic biology. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 8	   NEW MATERIALS Zero waste economy. Dealing with the most difficult tail end of the waste stream in concentrated form. Rapidly increasing risk, e.g. release of new materials such as nanomaterials during mechanical operations in waste treatment; more manual waste sorting on construction sites etc. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 9
   CONFLICT BETWEEN GREEN AND OSH Political pressure – grants, subsidies - OSH risks from work rushed before withdrawal of subsidies. - Risks shifting from professionals to unskilled workers (e.g. in house waste treatment by waste producer instead of waste professional owing to high waste disposal charges). Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 10	   CONFLICT BETWEEN GREEN AND OSH Conflict between Green and OSH Introduction of materials and processes that are green but hazardous for workers. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 11
   CONFLICT BETWEEN GREEN AND OSH Make-do-and-mend and refurbishing: - OSH risks from re-use of old equipment; - Increased need for maintenance work; - Increased manual repair work to recycle and re-use equipment. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 12	   CONFLICT BETWEEN GREEN AND OSH Sealed buildings Increasingly buildings are sealed to save energy. This leads to reduced ventilation during internal finishing work and increased exposure to dust, VOCs from paints or adhesives etc. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 13
   ZERO WASTE ECONOMY End of life – Recycling Increasingly legislation requires items to be manufactured with eventual disposal in mind, e.g. cars and electrical equipment. For example, fluids have to be removed from cars resulting in concentrating of potentially hazardous substances. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 14	   INNOVATION AND AUTOMATION Innovation and automation - Increasing levels of automation in all sectors could lead to safer working. - However, increasing complexity of processes and of the human machine interface could introduce risks, e.g. stress, MSDs - Over-reliance on computers could introduce risks. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 15

OSH Cards for Exercise 2

   INNOVATION AND AUTOMATION Automatic driving and platooning Self-driving vehicles are potentially very positive for OSH, although they bring the issue of over-reliance on the technology, and of its absolute reliability. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 16	   ZERO WASTE ECONOMY Zero-waste economy: Re-use of materials and products transferring risks to new environments, e.g. end-of-life batteries from vehicles being re-used to store electricity in buildings. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 17
   INNOVATION AND AUTOMATION Offsite manufacturing of building modules has improved safety on construction sites New risks from use of new substances and materials Issues on construction site from mixing automated activities with manual ones. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 18	   INCREASING RELIANCE ON ELECTRICITY Electric vehicles • Risks in maintenance - Workers unaware of high voltages (360-500V) • Risks to emergency services • Risks not confined to the vehicle - Risks from fuel cells Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 19
   SKILLS SHORTAGES Availability of skilled manpower. • New technologies will need people with skills, and long timescales are needed to achieve competence. • Increased risk of polarisation of the workforce (skilled vs. unskilled). Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 20	   DECENTRALISATION Small clusters of households with their own eco systems (mini-CHP; bio-digesters; PV systems etc.) are probably the least safe size for this sort of activity, with no central authority or "key-holder" responsible for safe operation. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 21
   LABOUR MARKET CONTEXT The contractorisation of industry leads to cost-cutting and poor OSH conditions. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 22	   INNOVATION AND AUTOMATION Rapid innovation may lead to a variety of OSH risks, with new materials and new processes, with little time to assess potential health hazards and to learn how to use them safely. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 23

OSH Cards for Exercise 2

   LABOUR MARKET CONTEXT Diverse workforce: fewer job opportunities in highly skilled green jobs for vulnerable groups, including female/older/migrant/disabled workers. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 24	   LABOUR MARKET CONTEXT Precarious work and polarisation of the workforce: high skilled jobs vs precarious working. Increasing automation and complexity may lead to a reduction in skilled manual work and increasingly precarious employment terms, e.g. zero-hours contracts could lead to polarisation of the workforce with poorer OSH conditions for unskilled workers. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 25
   INNOVATION AND AUTOMATION Automation is likely to be positive for safety in the long term. New processes bring risk, but automation is likely to be positive for OSH. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 26	   INNOVATION AND AUTOMATION Cobots Intelligent un-caged robots working closely with humans could introduce hazards in case of malfunction. Foresight of New and Emerging Risks to Occupational Safety and Health Associated with New Technologies in Green Jobs by 2020 27

