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EUCALC

Explore sustainable European futures

Identification of social and socio-economic issues and relevant indicators by stakeholders' survey and experts' co-design workshop

D6.3

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Short Description
This deliverable details the selection of the most important social and socio-economic issues and indicator by stakeholders' survey and co-designed expert workshop. These indicators will be used to compute socio-economic impacts of different transitions toward sustainable societies within the EUCalc project.

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1 Executive Summary

This deliverable aims at identifying the most important social and socio-economic issues -impacted by a deep energy transformation in Europe- and indicators to use in the EUCalc tool. In this regard, an online stakeholder survey and an expert workshop were performed. The goal of the stakeholder survey was to identify the most important socio-economic issues. Then, the predefined socio-economic issues were presented to experts in the workshop to validate them and to define relevant indicators.

Survey results showed that human health, employment and training and education were perceived by the majority of stakeholders as the three most important issues. The EUCalc expert workshop was designed to discuss the selected social and socio-economic issues selected by the stakeholders, and to obtain experts' advice on the best indicators to be used in the EUCalc tool. By means of such indicators, we aim to estimate social and socio-economic impacts of de-carbonization pathways and assess the interconnections with other WPs. Experts' workshop reinforced the results of the stakeholder survey, highlighting the importance of health, employment, and training and education. However, participants agreed on that integration of social and socio-economic impacts in the EUCalc tool would be associated with a high level of complexity. Designing health and employment indicators was perceived more feasible than those for education and training. Results of workshop showed experts perceived "mortality" and "life expectancy" as relevant indicators. Regarding employment, experts suggested to first consider the "total number of people employed". Finally, the number of people employed can be further delineated per economic sectors and per "skill" to provide relevant information for policymakers.

2 Introduction

De-carbonization through better transport, food and energy-use choices may lead to positive social and socio-economic effects (An individual's social class influences their behaviour, ideas and attitudes, however, socioeconomic status is a combination of an individual's work status as well as the individual's economic position based on income, education, and occupational prestige). In this regard, WP6 of EUCalc aims to analyse the medium and long-term (2030 and 2050)

social and socio-economic impacts of the de-carbonization pathways in Europe by linking climate change with social and socioeconomic indicators in an integrated assessment model. The social and socio-economic impacts of the de-carbonization pathways (*i.e.* different energy technologies, policy scenarios, and lifestyles), provide valuable inputs for policy makers and other stakeholders to take informed decisions and obtain public support for their actions. To build such impacts into the model needs careful consideration of key social and socio-economic issues. Developing and modelling social and socio-economic impacts in the EUCalc tool requires insights in the needs of stakeholders. Therefore, this task of the WP6 module aimed at identifying the main social and socio-economic issues, selecting the necessary indicators (to assess the social and socio-economic impacts of de-carbonization pathways), and deciding on the (quantitative) data and applicable methods to be used in the EUCalc tool.

3 Stakeholders' survey and expert workshop

3.1 Survey

The research design for identifying and defining social and socio-economic issues and indicators was based on a two-step approach: (1) stakeholders survey, and (2) expert workshop. First, we conducted a stakeholder survey to identify the top three most important social and socio-economic issues to be included in EUCalc tool (literature review was used to identify common/long list of socio-economic issues related with energy transformation and climate change while the survey was used to rank their importance). Second, indicators for the top three issues were presented to experts in the workshop for validation based on three criteria and 9 sub-criteria.

The stakeholders' survey was carried out from April to June 2017. A diverse range of opinions and stakeholder groups were targeted in the survey: civil society, industry, academia, certification bodies, government/ policy, advisor, consultant, and other business sectors (see Table 1 for stakeholders' population). An invitation to participate for an online survey was sent out to stakeholders by email. Partners of the EUCalc project nominated a list of stakeholders for the survey. Stakeholders in this study are groups expected to use the EUCalc tool

either for making policies or decisions in the different industrial sectors considered in the scope of EUCalc or other multiple potential users. Stakeholders' surveys were performed to explore the perceptions of stakeholders about social and socio-economic issues. These selected issues by stakeholders will be included in the EUCalc tool. The survey was conducted online and the questionnaire was structured as closed-end questions with nine sections (see appendix for the questionnaire). Prior to launching the survey, a pilot study was conducted to test the effectiveness and clarity of the questionnaire, after which it was refined and wording was adjusted. In the first section of the survey, its purpose and details were explained[1]. The questionnaire opened with a section on personal information of the respondent. In section two, professional background of the experts were asked. In section three, the stakeholders were asked to evaluate key social and socio-economic issues. Stakeholders were asked about which issues they consider to be most important to be included in EUCalc tool. Stakeholders were instructed to score social and socio-economic issues, using a five-point Likert scale (1-5), with the additional option of "no opinion" as an answer. Stakeholders were also given the opportunity to comment or propose additional issues. To explore the relative importance of the sustainability issues for stakeholders, the frequency distribution of the scores for each issue was used. For the frequency analysis, focus was placed on frequencies of the scores 4 and 5. In addition, the homogeneity of the scores for each issue was assessed using standard deviation. Furthermore, a Chi-square test was applied to make statistical inferences regarding the about the variation in responses among stakeholder groups. The test was carried out to evaluate whether the distribution of all scores (1–5) differed significantly between experts groups from different professional sectors. The explanatory text and online questionnaires are included in the Appendix.

Table 1–Overview of the stakeholders' population

Stakeholder groups	N=Valid number of responses
Academia	28
Civil society	10

[1] https://www.surveymonkey.com/r/EUCalc

Industry and business	20
Certification bodies	5
Government/ policy, advisor	6
Consultant	10
NGOs	7
Total	86

The literature review was performed to identify a list of the most commonly discussed social and socio-economic issues (see Table 2). From the literature review, 13 social issues were selected for inclusion in the Stakeholders survey (Table 2).

Table 2– Social and socio-economic issues, selected from the literature review, with description of the issues and default indicators

Issues	***Description***	***Examples of default indicator***
Working conditions	Working conditions refer to the working environment and all existing circumstances affecting labour in the workplace, including job hours, physical aspects, legal rights and responsibilities.	Working hours; wage level; work life balance measure
Labour rights	Labour Rights refer to the group of legal rights and claimed human rights having to do with labour relations between workers and their employers, usually obtained under labour and employment law.	Employment relations; forced labour; child labour; employees' freedom of association; right to bargaining
Employment	Employment refers to total number and rate of new employee hires and employee turnover by age group, gender, and region.	Skill composition; job creation; gender pay gap; Nominal unit labour cost; number of green jobs.
Training and education	Training and education refers to education in general and opportunities to acquire the skills and knowledge necessary to undertake current and future tasks required by the enterprise for employees, as well as the resources to provide for further training and education for employees and members of their families.	Average hours of training per year per employee by gender, and by employee category; percentage of employees receiving regular performance and career development
Equity	Equity involves the degree of fairness and inclusiveness with which resources are distributed, opportunities afforded and decisions made.	Discrimination level; gender equality; gender pay gap
Human health and safety	Human health and safety is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations.	Physical and psycho-social health; life expectancy, morbidity, mortality
Cultural diversity	Cultural identity is composed of ethnicity, language and religion and cultural diversity refers to the innumerable forms taken through the process of acculturation, included but not limited to age, sexual orientation, economic status, spiritual belief and political affiliation.	Indigenous knowledge, food sovereignty
Food security	Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.	Availability; accessibility; utilization; stability
Energy security	Energy security is linked to either physical availability of energy, or prices that are competitive or are overly volatile.	Primary energy mix; total primary energy supply per capita; final energy consumption per capita; net import dependence; Gas Vulnerability Index (GVA)
Social cohesion	Social cohesion is defined as a cohesive society that works toward the wellbeing of all its members, fights exclusion and marginalization, creates a sense of belonging, promotes trust and offers its members the opportunity of upward mobility.	Migration and resettlement; wealth distribution; fair wages; unpaid work; charity; risk of poverty; expenditure on social services per capita
Standard of living	Standard of living refers to the level of wealth, comfort, material goods and necessities available to a certain socioeconomic class in a certain geographic area, usually a country.	Health services; security; public service support; access to energy services
Social	Social development is defined as prioritizing human needs in the growth and progression of	Local prosperity; fair trade; unpaid work

development	society. The focus is on improving the lives of regular citizens, especially the poor, to make society a better place for everyone.	(household, childcare, etc.).
Happiness	Happiness refers to the experience of joy, contentment, or positive well-being, combined with a sense that one's life is good, meaningful, and worthwhile.	Suicide rate, buying power, subjective satisfaction.
References: Organization for Economic Co-operation and Development (OECD), Global Reporting Initiative (GRI), International Labor Organization (ILO) or the World Health Organization (WHO)		

Regarding stakeholders, a big sample size (The survey questionnaire was distributed among 298 stakeholders. A total number of 99 responses were received. Out of the 99, responses, only 86 were valid, representing a response rate of 28%) was selected; however, not all of them were willing to answer the questionnaires. A total number of 86 questionnaires were successfully completed and returned (Table 1). **Error! Reference source not found.** shows the descriptive statistics (i.e., mean, standard deviation and frequency of scores 4 and 5) of data. To explore the relative importance of the social and socio-economic issues for stakeholders, the frequency distribution of the scores for each issue was used. Since the objective of the survey was to assess which social and socio-economic issues are important, the analyses focused on the frequencies of the scores 4 (important) and 5 (highly important). We used the frequency distribution of the scores for each issue to show the percentage of the selected issues by stakeholders which was focused on the frequencies of the scores 4 and 5. In addition, the distribution of scores for each issue was assessed using the standard deviation. We tried to show by this means how the scores were distributed. For instance, a low standard deviation here indicates that the distribution of the scores does not have high variation or the data points tend to be close to the mean of the set. A Chi square test of homogeneity of responses was used to make statistical inferences about the variation in responses among stakeholder groups (Petit and Van der Werf 2003). The test was carried out to evaluate whether the distribution of all scores (1–5) differed significantly for stakeholder groups[2].

Scores obtained from stakeholders for social and socio-economic issues revealed that 'human health and safety' was perceived by the majority (97%) of stakeholders as the most important issue. Then 'employment' and 'training & education' were also perceived as important issues by the majority of stakeholders (90.7% and 92.3%). Moreover, these three issues had the lowest SD, or in other words variation in the stakeholders responses were lower in these issues compared to for instance happiness with higher SD. Cultural diversity and social cohesion, however, were perceived as the least important issues (56.3%

[2] A chi-square test for independence compares two variables in a contingency table to see if they are related. In a more general sense, it tests to see whether distributions of categorical variables differ from each another.

and 48.5%). In addition Chi-Square test results showed that the difference in underlying distributions of total scores (1–w) was not statistically significant for respondents for all issues (P≥0.05). This implies that Stakeholders in different sectors did not have different perceptions concerning the importance of the issues. Table 3 shows the statistical analysis of stakeholder survey and issues with highest and lowest score in each issue. Based on the results of the stakeholders' survey, the three most important issues were selected (indicated by the bold font in the table), namely: 'Human health and safety', 'employment', and 'training & education' as the issues to be further discussed with the experts and to define indicators for.

Table 3– Descriptive statistics of the stakeholders' perceptions about the importance of Social and Socio-economic issues to be included in EUCalc

Issues	**Importance N=86**			
	M	**SD**	**F %**	**Chi-square *P* value**
Working conditions	3.95	0.605	83.0	0.795
Labor rights	3.80	0.639	76.7	0.644
Employment	**4.15**	0.561	90.7	0.156
Training and education	**4.13**	0.519	92.3	0.615
Equity	**3.64**	0.689	81.4	0.109
Human health and safety	**4.36**	0.537	**97.0**	0.402
Cultural diversity	3.51	0.774	56.3	0.756
Food security	3.72	0.654	86.0	0.856
Energy security	4.09	0.556	91.0	0.739
Social cohesion	3.76	0.728	48.5	0.862
Standard of living	3.89	0.639	76.6	0.176
Social development	3.85	0.629	75.0	0.396
Happiness	3.65	**0.944**	75.1	0.207
Total	3.95	0.202	-	-

M: Mean value
SD: Standard deviation
F: Frequencies of scores 4 and 5
P value of Chi square test: If P≤0.05, the result is statistically significant (less homogeneous)

Bold numbers represent the highest means and frequencies for each issue
Underlined numbers represent the lowest mean, standard deviation and frequencies for each issue

3.2 Expert workshop

In the workshop, we aimed to define the appropriate indicators in order to proceed to the assessment of the social and socio-economic impacts. The direct process to select such indicators was inspired by the procedure suggested by Cloquell-Ballester et al. (2006). The steps here proposed are: (1) to check the potential indicators for the issues that have been selected by stakeholders; (2) to evaluate the possibility of the indicator for being used specifically in the EUCalc tool based on specific criteria; (3) to adjust or define ex novo the indicators, if the selected indicator is not fully applicable to EUCalc; and (4) to evaluate the relation between EUCalc levers and the indicators.

The major goal of the workshop was to assess which indicators are appropriate for the EUCalc scope. Therefore, the EUCalc expert workshop was designed to provide and evaluate the use of specific quantitative social and socio-economic indicators that should be used in the EUCalc tool. The workshop was convened by 20 participants in Delft, the Netherlands on the 1st of December 2017 (the list of participants is presented in appendix). The whole group included experts, a representative from the EUCalc consortium, and a facilitator with long applied experience on the elicitation methodology, e.g. the criteria and levers approach. Participants were motivated to think creatively to link decarbonisation pathways with social and socio-economic indicators and to further define the most feasible ones for the EUCalc tool. The workshop began with an introduction to the European Calculator and inspiring talk on the socio-economic determinants and impacts in Europe. Two short presentations over the course of the workshop stimulated the discussions with insights from research projects conducted by Ecofys and Stockholm Environmental Institute (please see agenda in apendix). The presentations and discussions held during the meeting will be basis for the development of a scientific publication[3] and the EUCalc's socio-economic module. Discussion regarding indicators was considered to be done based on the three criteria proposed by Cloquell-Ballester et al. (2006): (Table 4).

[3] Performance indicators for social impacts of de-carbonization pathways in Europe (in prepration) Farahnaz Pashaei Kamali, Thurm Boris, Marc Vielle, John Posada, Patricia Osseweijer

Table 4– description criteria and sub-criteria for validation of the indicators adapted from Cloquell-Ballester et al. (2006)

Criteria	Sub-Criteria	Description
Conceptual coherence	Relevance	Indicators should measure key properties of society that can be affected by mitigation of the climate change
	Clearly defined and standardized	Indicators must be based on clearly defined, verifiable and scientifically acceptable data collected using standardized methods so that they can be reliably repeated and compared against each other
	Easily communicated and understood	The indicators should be simple enough to easily communicated and understood by all stakeholders.
Operational coherence	Quantification	Indicators should be fully quantified whenever practicable. Counts and continuous variables (interval and ratio scales) are more favored than ranks (ordinal scales) or 'yes/no' scores (binary); any form of quantification is preferable to a fully qualitative assessment.
	Affordable measurement (measurement methods & reliable data availability/accessibility)	Affordable measurement means practical methods and tools for indicators assessment should be available. The data to evaluate a specific indicator should be accessible and the source of data which the indicator is made up of must be suitable and reliable.
	Operational simplicity	Indicators should be simple to measure, model, manage and analyze.
Utility	Spatial and temporal scales of applicability	Indicators should provide information at the right spatial and temporal scales.
	International compatibility	Indicators should be compatible and used in other regions, applicable to many areas, situations, and scales.
	Links with management (energy technologies and lifestyles)	Well established links with specific management practice or interventions

The second round of discussion was done to define the relation of the EUCalc levers with the pre-selected indicators. The list of primary levers was presented to experts in the workshop (see Table 5). Experts argued if there was a direct relation between any lever and the indicators, and if there was a rationale for such relation.

Table 5– List of EUCal levers (in progress at the time of workshop)

Module	Section	Lever		Module	section	Lever
Life style	Demography	Population		**Industry**	Technology	Design, material and recycling
		Urban population				Energy efficiency in energy-intensive industry
	Economy	GDP				Product lifetime
	Diet	Diet				Raw material demand
Climate		Temperature				Fuel switch
		Solar radiation				Carbon capture use and storage

		Wind
		GHG and aerosol concentration
Technology		Learning rate
		Capex
		Opex
		Efficiency factor
		Decommissioning
Building	Technology	Envelope quality
		Technology share
		Appliance efficiency
	Lifestyle	Building size
		Temperature and hot water use
		Lifting and appliance use
		Renovation rate and depth
		Household size
		Use intensity
		Cooling behavior
Transport	Technology	Efficiency
		Technology share
	Lifestyle	Passenger distance
		Freight distance

Land use		Allocation
		Usage efficiency
Minerals		Fossil fuel
		Minerals
Agriculture	Production	Crop yield
		Livestock
	Waste and residues	Waste and residues
Water		Water
Biodiversity		Biomass
		Biodiversity
Electricity	Renewable (electricity heat)	Wind capacity Biomass capacity Solar capacity Other renewables
	Fossil	Fossil fuel (coal, oil, etc. capacity)
		Ratio of CCS
	Nuclear (electricity-heat)	Nuclear capacity
	Balancing strategy	Nuclear gas, storage & demand shifting, export-import
Fossil fuel	Economy	Fuel economy
		Carbon price
	Technology	Efficiency

In the workshop recommendations were provided on the suggested indicators for further refining, merging, and/or deleting from the list, or even adding other indicators as well as some methodological aspects (see table 6, 8, 10). In the next step, experts were asked to discuss the relations between levers and indicators.

The list of indicators for the three most important issues were. Each issue was assigned to a working group for discussion:

- Discussion Group 1: on human health and safety
  - Mortality
  - Morbidity
  - Disability free life expectancy
  - Rate of sick leave
  - Mortality
  - Life expectancy
- Discussion Group 2: on employment
  - Employment to population ratio (EPR)
  - Overall employment growth
  - Number of green jobs
  - Gender composition
  - Unemployment rate by gender
  - Nominal and real unit labour cost growth

    - Gender pay gap in unadjusted form
    - Tax rate on low wage earners-unemployment trap
- Discussion Group 3: on training and education
    - Average hours of training per year per employee percentage of employees receiving regular performance and career development
    - The budget share of governments spent on education
    - Literacy rate
    - Skill composition
    - Operating expenditure per student
    - Number of programs for education for sustainable development

3.3 Health

In the workshop, experts considered human health as both a relevant and important issue. There is limited number of studies showing the improvements on health due to de-carbonization or climate change mitigation actions. Experts, likewise had concerns regarding quantifiability, affordability of measurement (measurement methods & reliable data availability/accessibility), and simplicity of use for this indicator. Experts' opinion is supported by WHO, since the global, regional, and urban scales are all needed to assess mortality (WHO 2014). Moreover, up-to-date health data (e.g. baseline incidence) and projections (including climate change (mitigation) and air pollution emissions explicitly) are needed, but this data currently is not available for all countries. However, according to experts there are different factors that may influence mortality. For instance, age is such a strong predictor of death and the age distributions of members of different populations vary. The age-adjusted mortality rate can be an indicator which allows comparison of mortality across different populations was suggested by experts. However, experts had a consensus that it is extremely challenging to assess the mortality related to all the de-carbonization effects.

To evaluate morbidity effects of the climate de-carbonization actions, epidemiological studies would be needed to explore the relationships between changes in air pollution levels and the short-term and long-term consequences on health. Epidemiological studies are generally not available for most air pollutants. Hence, although morbidity is a relevant indicator, it is more difficult to collect data, and it is not practical in the context of EUCalc. Moreover, DALY, from a measurement point of view, is not applicable in the context of EUCalc.

According to experts, life expectancy is probably a feasible indicator compared to other indicators. Experts discussed that, by using published data on excess mortality (From WHO), we can connect climate change excess mortality to life expectancy (or mortality rate reduction of climate change mitigation to life expectancy). In addition, experts argued that there might be not proper datasets available for all countries specifically for sick leaves related to climate change sicknesses. Table 6 shows health indicators and their compatibility with the nine pre-defined sub-criteria based on experts' perceptions. Plus signs in the tables mean that experts had a positive perception regarding that criteria and sub-criteria (e.g., they discussed that finding data for mortality is possible); a minus sign means that experts had a negative perception regarding that criteria and sub-criteria. And a plus/minus combination means that experts were unsure or that there was no consensus. In the light of experts' feedback, the chosen indicators for human health are mortality rate and life expectancy.

Table 6– summary of expert discussions regarding health indicators and their compatibility with the pre-defined sub-criteria

		Health indicators					
Criteria	**Sub-criteria**	***Mortality***	***Life expectancy***	***Rate of sick leave***	***Disability adjusted life years***	***Morbidity***	***Out-of-pocket payments healthcare expenditure***
Conceptual coherence	**Relevance**	+	+	+	+	+	+
	Clearly defined and standardized	+	+	+	-	+/-	-
	Easily communicated and understood	+	+	+	+	+	-
Operational coherence	**Quantification**	+/-	+/-	+/-	+/-	-	-
	Affordable measurement	+/-	+/-	+/-	-	-	-
	Operational simplicity	-	+/-	+/-	-	-	-
Utility	**Spatial and temporal scales of applicability**	+	+	-	-	-	+
	International compatibility	+	+	-	+	-	+
	Links with management	+	+	-	+	-	-

Indicators already ranked from more compatible to less compatible.

'+' relation between indicator and criteria is positive, '-' relation between indicator and criteria is negative.

According to experts, there is direct causal relation between air pollution induced by energy technology/fuel and human health. Experts also highlighted direct relation between water, waste and residues and learning rate[4] with health indicators. Experts perceived population, GDP, and diet as levers with a direct and strong relation with health indicators. Experts indicated that even simple improvements in diet quality could significantly improve health, and conversely, worsening the diet quality may increase health risks. On the other hand, intake of fruits and vegetables is relevant, since meat reduction can reduce methane emission. Also, wastes and residues was selected as a lever with direct relation with human health and wellbeing indicators such as mortality and life expectancy. Energy poverty for household was one of the additional indicators suggested by experts in the workshop. According to experts, the combination of prolonged winters due to climate change and poor housing situation leads to energy poverty. Table 7 shows the list of levers which have relations with human health indicators and their potential links. The results of this part of discussion will assist us in developing the module and indeed integration of the module in the tool and linking socio-economic module to levers and also pathways.

Table 7– summary of expert discussions regarding human health indicators and their potential relations with levers

Lever	*Rationale*	*Indicator*
Population	• Social services	Morbidity rate
Urban population	• Affecting land availability and ecosystem services (access to green areas/food/water) • Affecting quality of life	Disability free life expectancy
GDP	• Higher exposure to risks • Poverty/energy poverty	Disability free life expectancy
Diet	• Affecting the land use and environment • Obesity • Nutrition scarcity	Mortality rate Morbidity rate Life expectancy Disability free life expectancy
GHG and aerosol concentration	• Air pollution exposers	Mortality rate Morbidity rate

[4] In energy models endogenous technical change is introduced by implementing so-called energy technology learning rates, which specify the quantitative relationship between the cumulative experience of the technology and cost reductions.

		Life expectancy Disability free life expectancy
Temperature & climate (extreme weather events)	• Access to clean water, ecosystem services • Spread of new diseases • Affecting the conditions for outside work	Mortality Morbidity Rate of sick leave Disability free life expectancy
Transportation mode	• Affecting the air quality and physical activity	Mortality Morbidity Rate of sick leave Disability free life expectancy
Water	• Access to clean water • Access to enough water	Mortality Morbidity Rate of sick leave Disability free life expectancy
Technology/fuel	• Affecting the air quality	Disability free life expectancy Rate of sick leave (number of hospitalizations) Mortality Morbidity
Waste and residues	• Exposure to leaching and food and water contamination	Disability free life expectancy Mortality Morbidity Life expectancy

3.4 Employment

Decarbonizing actions of European countries can be seen as an opportunity to increase employment following the "double dividend paradigm" or the substitution of energy intensive goods with labour intensive goods.[5] In the workshop, experts confirmed the importance and relevance of including employment indicators in the EUCalc tool (Table 8). They discussed what metrics would be adequate for the calculators, reviewing the selected indicators but also suggesting new ones. Experts assessed the indicators through the prism of one key question: "*How do people get into employment from unemployment?*"

[5] For studies discussing the impacts on employment of energy transition, see for instance Lehr et al., (2012), Cambridge Econometrics (2015) and Hartwig et al. (2017).

The first indicator suggested by experts was the number of people employed. This output is of the highest importance and is a good starting point to implement more detailed indicators. The number of people employed can be further linked to the additionally suggested indicators "Overall Employment Growth" and "Employment to population ratio" (i.e. the number of people employed divided by the active population). In the context of the EUCalc, the use of the number of people employed as indicator has three practical advantages: i) statistics are available in EUROSTAT (the Labour Force Survey (LFS)[6] dataset provides quarterly and annual data), ii) the indicator is easy to understand, and iii) the number of people employed can be further delineated per economic sectors and per skill to provide relevant information for policymakers.

The LFS provides data on the number of people employed per activity sector. According to experts, another crucial point is to know the share of production based in the EU. Increasing the production in one sector may not increase employment if the production is outsourced to the rest of the world. Thus, imports and exports play an important role for the EUCalc tool. The amount and composition of trade requires a serious detailed analysis. This stresses out the need for a close cooperation between key work packages (WP6 on Social Impacts and WP7 which deals with Trade).

Delineating the number of people employed by skill levels was highlighted as a key output for the EUCalc. Skills are important for the issue of "moving from unemployment into employment". The employment by skill levels is closely linked to the training and education issue, for example to an indicator on the number and level of education per sector. The LFS provides data on the number of people employed per educational attainment level. The GTAP (Global Trade Analysis Project) database also distinguishes five types of labor value added: Official and Managers, Technicians, Clerks, Service/Shop workers and Agricultural and Unskilled[7].

Another indicator prioritized by the experts was the wage levels by sector since it provides valuable information on how productive an economy is. However, the EUCalc team will have to consider the data availability and the modelling options.

[6] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Labour_force_survey_(LFS) and http://ec.europa.eu/eurostat/web/lfs/overview

[7] Details on the disaggregation are available here: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4867

Others preselected indicators such as the gender composition, the unemployment rate by gender, the gender pay gap or the unemployment trap were found less relevant by experts. Indicators about unemployment have a negative connotation, thus EUCalc should prioritize employment indicators. Employment by gender is linked to numerous causes including skills/education levels, family and child care policies, and many other factors affecting the participation of different groups in labour markets. Hence, delineating employment per gender would be difficult to manage in the EUCalc.

The number of green jobs was also considered problematic by experts. First of all, there is not a unified definition of green jobs, and therefore it is challenging to classify a job as green. The definitions proposed by the International Labor Organization (ILO) and the United Nations Environment Program (UNEP) were most used ones. ILO defines green jobs as "jobs that contribute to preserve or restore the environment, be they in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency"[8]. On the other hand, green jobs sometimes refer only to jobs in environmentally-friendly sectors. Consequently, this creates difficulties in comparing the methods and results of different studies. Table 8 summarizes experts' discussion regarding employment indicators and their compatibility with the nine pre-defined sub-criteria in a semi-quantitative way. Plus signs in the tables mean that experts had a positive perception regarding that criteria and sub-criteria (e.g., they discussed that finding data and method of assessment for skill composition is possible); a minus sign means that experts had a negative perception regarding that criteria and sub-criteria. And a plus/minus combination means that experts were unsure or that there was no consensus. In the light of experts' feedback, the chosen indicators for employment are number of people employed per sectors, the skill composition and the evolution of wages.

[8] http://www.ilo.org/global/topics/green-jobs/news/WCMS_220248/lang--en/index.htm

Table 8– summary of expert discussions regarding employment indicators and their compatibility with pre-defined sub-criteria

Criteria	Sub-criteria	Number of people employed per sectors	Skill composition	Wages per sector	Gender indicators	Unemployment indicators	Nominal unit labour cost	Number of green jobs
Conceptual coherence	Relevance	+	+	+	+/-	+/-	+/-	-
	Clearly defined and standardized	+	+	+	+	+	+	-
	Easily communicated and understood	+	+	+	+/-	+/-	-	-
Operation coherence	Quantification	+	+	+	+	+	+	+
	Affordable measurement	+	+	+/-	-	+/-	-	-
	Operationally simplicity	+	+	+/-	-	+/-	-	-
Utility	Spatial and temporal scales of applicability	+	+	+	+	+	+	+
	International compatibility	+	+	+	+	+	+	+
	Links with management	+	+	+/-	-	+/-	-	-

'+' relation between indicator and criteria is positive, '-' relation between indicator and criteria is negative.

Experts highlighted the role of behavioural and technological changes for employment impacts. They pointed out that there could be a significant change in the number of people employed if everyone becomes vegetarian/vegan, opts for smaller living spaces, heats less, buys less appliances, consumes more services, or if there is a shift from steel/cement to wood as a construction material. Disruptive technologies such as driverless cars or an increase in automation also plays a crucial role for employment level (Arntz and Zierahn, 2016). This supports the importance of delineating the number of people employed by sector and by skill levels to better understand the employment impacts answering questions such as which industries and population group are more affected.

Experts outlined several other factors that will strongly shape employment level and structure across Europe both in the medium and long-run, such as demographic structure, climate change and climate change mitigation Another key factor discussed was European competitiveness. Experts suggested introducing it in the EUCalc tool as a new lever. Indeed, most sectors will face increasingly strong competition in coming years, and the group was interested in seeing the tool answer some of the following questions: if Europe needs to produce steel and cars, how much of these will be created inside and outside Europe, or if Europe goes solar, what share of the global solar industry will be based in Europe. This confirms the need for a close cooperation between work packages (WP6 on Social Impacts and WP7 on Trade). However, competitiveness depends on many factors such as labour productivity, labour cost, skills, innovation, or the regulatory framework. Experts acknowledged that assumptions about technology availability, industry share in Europe, as well as skill level of the EU, are complicated to make. If a competiveness lever is introduced, the EUCalc project must be transparent on the assumptions behind to enhance the users' trust in the EUCalc tool. Regarding WP6, the levers will not be included in the societal module (not in WP6), but directly in the sectoral modules following discussions with partners. For decision and policy makers, it is important to clarify what kind of reskilling and re-training will be required, and to ensure that a safety net exists to protect against risks of rising unemployment. Consequently, experts stressed out the need for a strong link in the EUCalc between employment and education/training, research and development.

Moreover, experts proposed that the EUCalc could look at the impacts on income per capita. In this regard, it would be essential to better understand the correlation between employment and wages and levers such as demography, GDP and energy prices. Finally, experts suggested the introduction of a new lever in the EUCalc: "Labour regulation". Indeed, the regulatory framework is a key driver of the labour lever. Regarding the labour regulation lever, although we are considering it, this would not only be quite challenging to implement (many potential policies to include) but also not that relevant. The reason why is that the objective is to compare the impacts on employment in the user's scenario with respect to the baseline scenario. In other words, we are not predicting what will be the employment in 2050 (that would be outside of the economics modelling availability). Rather, we compare two scenarios to clearly identify the effects of the decarbonisation. Having different regulations in these two scenarios would not make sense (note that the baseline will use business as usual regulation) and might be confusing because it would be unclear what are the effects of the regulation and what are the effects of decarbonisation. Thus, it might be interesting to design a "full employment" scenario. In this case, the employment level would be driven by regulation and policies through this lever. However, as a counter argument, it was pointed out that the EUCalc does not fix "full employment" as a target but rather measures the impact of various climate mitigation strategies on the structure and the level of employment. Table 9 summarizes the list of levers which have relations with Employment indicators and their potential links. The results of this part of discussion will assist us in developing the module and indeed integration of the module in the tool and linking socio-economic module to levers and also pathways.

Table 9– summary of expert discussions regarding employment indicators and their potential relations with levers

Lever	Rationale	Indicator
Population	• More people could increase employment, but not wage (wage pressure) • Demography should be defined per variables (age, immigration, rural/urban)	Total number of employees, Wage

GDP	• Higher GDP means more production, and thus more employment and possibly higher wages • There is correlation between GDP and income	Wage
Energy prices	• Higher prices, less expendable income • Impact on wages unclear	Income (Expendable)
Technological development	• Affect productivity / labour intensity	Total number of employees, Wage
Automation	• Affect the skill levels of jobs (jobs shifting). • More high skilled jobs combined with automation results in loss of jobs.	Skill composition, Wage
Behaviour change	• Change the sectoral production, and thus the number of jobs per sector and per skill levels	Skill composition, Wage
Climate	• Affect working condition and the productivity • Affect the sectoral and geographic employment opportunities and the skill levels needed	Skill composition, Wage
EU competitiveness	• Affect the location of labour	Total number of employees
Labour regulation / policies	• Limits or stimulates employment • Suggestion to include it as a new lever	Total number of employees

3.5 Training and education

Experts argued that, it is difficult to link education indicators to de-carbonization pathways. The working group of experts suggested considering the number of graduate and post-graduate education in energy sector as an indicator for this issue. Experts argued that attention should be on sustainability-related education plans, Experts argued that climate change-related education is therefore a subject that fits well within the education for sustainable development agenda. However, experts had uncertainties about the available data regarding all European countries for all levels of education. Experts also discussed that connecting education to de-carbonization pathways can be challenging. In other words, this indicator might be easy from a conceptual and an operational point of view, however, from its utility point of view, it is difficult to use.

Experts argued that as an alternative, skill composition can be a more proper indicator than average hour of training (this indicator was discussed in employment section). Table 10 shows the summary of the validation of the pre-selected training and education indicators based on the nine sub-criteria. Table

10 summarizes experts' discussion regarding education and training indicators and their compatibility with the nine pre-defined sub-criteria in a semi-quantitative way. Plus sign in the table shows relation between indicator and criteria is positive; minus sign shows relation between indicator and criteria is negative; and plus/minus shows experts either were not sure or did not have consensus. In the light of experts' feedback, the chosen indicator for education and training is skill composition; however, this indicator was selected also in the employment category and will be modelled in that part.

Table 10– summary of expert discussions regarding training and education indicators and their compatibility with pre-defined sub-criteria

Criteria	Sub-Criteria	Skill composition	Literacy rate	The budget share of governments spent on education	percentage of employees receiving regular	Average hours of training per year per employee	Number of programs for education for sustainable development
Conceptual coherence	Relevance	+	-	+	+	+	+
	Clearly defined and standardized	-	NA	-	-	-	-
	Easily communicated and understood	+	NA	+	-	-	-
Operational Coherence	Quantification	+	NA	-	+	+	-
	Affordable measurement	+/-	NA	-	+	+	-
	Operational simplicity	+/-	NA	-		+	-
Utility	Spatial and temporal scales of Applicability	+	NA	-	+	+	+
	International compatibility	+	NA	-	-	-	+
	Links with management	+	NA	-	-	-	-

'+' relation between indicator and criteria is positive, '-' relation between indicator and criteria is negative, 'NA' Not applicable: Indicator was dropped due to being irrelevant.

Experts highlighted the relation of education, population and de-carbonization pathway. Experts discussed that population should not be ignored in de-carbonization and adaptation policies and strategies. Population policies and programs that promote universal access to education, mostly sustainability education, will help lead to a more sustainable demographic future that will play a crucial role in de-carbonization.

In addition to population size, level of education, the distribution of people in urban and rural areas, and household size generate substantial effects on the climate system. Another relevant lever, which was selected by experts, was GDP. A higher percentage of GDP spent on education shows a higher government priority for education. Moreover, experts argued that mitigation can be results of education geared from learning how to change lifestyles such as diets. In addition, learning curve able to depict the time required to learn certain information, and acquire certain skills, which has a direct link with education for employees. Experts argued that the direct relation exits between learning curves of the various technologies and skill composition. Table 11 summarizes the list of levers which have relations with education and training indicators and their potential links. The results of this part of discussion will assist us in developing the module and indeed integration of the module in the tool and linking socio-economic module to levers and also pathways.

Table 11 – summary of expert discussions regarding education and training indicators and their potential relations with levers

Lever	Rationale	Indicator
Population	• More resource available for low populated societies	Energy literacy, The budget share of governments spent on education
Urban population	• Access to better education	Number of programs for sustainable development
GDP	• More finance for education	Energy literacy, Number of programs for sustainable development, Number of programs for education for sustainable development, The budget share of governments spent on education
Diet	• More educated people, changing diet pattern (e.g., less meat consumption)	Energy literacy, The budget share of governments spent on education
Learning rate	• Learning of the various	Skill composition

4 Databases

For health the main database includes GTAP 9, WHO mortality and EEA database. Our estimates of emission data are from the GDyn-E results in terms of GTAP 9 database. In GTAP 9 database, the emissions dataset is compiled using data from the EDGAR (Emission Dataset for Global Atmospheric Research) Version 4.2 (2011) dataset for non-agricultural activities, and from FAOSTAT (2014) emissions dataset for agricultural activities directly as inputs into the build. Another database that we will use is EMEP/EEA air pollutant emission inventory Guidebook (EMEP/EEA Guidebook), which is the accepted methodology for reporting for the National Emissions Ceiling Directive NECD. Using the emissions factors from this guidebook, we would be able to quantify emissions from different sectors in different member states for different 'calculator' scenarios.

For employment, we use the GTAP 9 – Power database (Peters, 2016) to calibrate the economic model and the Exiobase dataset (Tukker et al., 2009) to refine the representation of the Transport sectors (distinction between Rail and Road). We also use data on household budgets from the COICOP database, available in Eurostat.[9] Finally, data on the number of people employed per activity branches and per educational level are compiled thanks to the Labour Force Survey in the Eurostat database.[10] More details on the reconciliation of these databases are available in Deliverable 6.1 (Thurm et al, 2018). The assumptions made and the methods used will be further explained in forthcoming Deliverables D6.6, D6.8 and D8.7.

5 Conclusions

The three most important issues selected by stakeholders were "human health", "employment" and "training and education". In the expert workshop, human health and employment indicators were perceived more feasible than those for

[9] Description of the database: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Classification_of_individual_consumption_by_purpose_(COICOP);
Dataset: http://ec.europa.eu/eurostat/web/products-datasets/product?code=nama_10_co3_p3

[10] Description of the Labour Force Survey and dataset : http://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey

education. There had been consensus amongst participants on removing some of the pre-selected indicators. Moreover, there were widely diverging degrees of uncertainty regarding the applicability of different indicators (e.g. morbidity, sick leave rate, and gender pay gap). Participants concluded that there is a great deal of complexity regarding the application of social and socio-economic indicators for de-carbonization pathways in a tool such as the EUCalc. Finally, the most straight forward indicators to be integrated in the EUCalc too selected by the experts were: "mortality", "life expectancy", "number of people employed per sectors" and "skill composition".

Experts concluded that further experience in the actual development and application of these indicators in various countries is necessary and will need to be documented for further knowledge sharing. The next step will mainly cover the application of the selected feasible indicators in EUCalc tool. TUDelft and EPFL in the next steps will quantify mortality, life expectancy, number of people employed per sectors and skill composition for EU countries as socio-economic module. For instance, TU Delft will provide a model for impacts of five air pollutants on mortality and life expectancy in the next step of WP6 activities. Moreover, an initial version of the employment module for Germany was developed by EPFL using the KNIME software. The objective was to test the method developed, before expanding it to the other EU28 countries and Switzerland. It will further be expanded in order to delineate employment by skill levels (i.e. educational attainment) and for other EU countries. The Employment and Health modules will be integrated into the consolidated model in Month 24, in order to be finalised by Month 33.

6 Acknowledgements

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8 Appendix

Stakeholders' Survey: Social issues for European calculator (EUCalc)

We would appreciate if you would kindly cooperate and fill in this short questionnaire about the important social issues to be included in EUCalc.

This survey is part of the EUCalc project. This project will deliver an urgently needed comprehensive framework for research, business, and public sector decision makers which identifies and enables an appraisal of synergies and trade-offs of feasible European decarbonisation pathways until 2050. The EUCalc is a free and interactive tool that helps you to understand the link between our lifestyles, the energy we use, and the consequences for our climate. In other words EUCalc explores the impact of the choices that can be made in different sectors, including power and heat generation, transport, industry, buildings, agriculture, food and of the underlying lifestyle choices of Europe's citizens in terms of the climatological, societal, and economic consequences. The socio-economic impact of the different scenarios on society and economy (jobs, competitiveness, fuel poverty, etc.) is a key asset of the EUCalc. It provides valuable input for policy makers and other stakeholders to take informed decisions and obtain public support for their actions.

Hence, this survey investigates the operational experiences of people actively involved with social and socio-economic aspects of sustainability. The full questionnaire will take around 10 minutes of your time. Your responses will be treated as confidential and data from this research will be reported only in an aggregated form. We would highly appreciate your participation and hope to receive your answers before 15 of March 2017.

In case of need for more clarification regarding the social issues brought up in this survey, please feel free to refer to the explanatory sections provided at the end of this questionnaire.

Section 1, is the description of the issues which provides you a better view point before filling in the questionnaire. Section 2 includes questionnaire.

EUCALC

Section A: description of the issues

Social and socio-economic issues	Description
Working conditions	Working hours; wage level
Labor rights	Forced labor; child labor; freedom of association and bargaining; capacity building
Employment	Total number and rate of new employee hires and employee turnover by age group, gender, and region.
Training and education	Average hours of training per year per employee by gender, and by employee category; programs for skills management and lifelong learning that support the continued employability of employees and assist them in managing career endings; percentage of employees receiving regular performance and career development reviews by gender
Equity	Non-discrimination; gender equality; support to vulnerable people
Human health and safety	Physical and psycho-social health; health resources
Cultural diversity	Indigenous knowledge, food Sovereignty
Food security	Enough land locally available for food production including agricultural set aside land; preference of marginal sites for energy crops
Energy security	Energy security is linked to either physical availability of energy, or prices that are competitive or are overly volatile
Social cohesion	Migration and resettlement; wealth distribution; fair wages; charity
Standard of living	Health services; security, public service support; access to energy services (e.g. electricity lifeline tariffs)
Property rights	Land and resource tenure; dependencies on foreign sources (e.g. financial investments, knowledge) fair and equal division of proceeds; customary rights
Social development	Local prosperity; fair trade
Happiness	The experience of joy, contentment, or positive well-being, combined with a sense that one's life is good, meaningful, and worthwhile

Section B: background and professional expertise

Your background (1/2)

1. **Contact data**

Last name: .....

First name: .....

Company/ organization.....

Email:.....

Country (obligatory): .....

2. **What is your segment of profession (obligatory):**

☐ Environmental NGO's ☐ Social NGO's ☐ Government/Policy

☐ Industry ☐ Academia ☐ Advisor/ consulter

☐ Certification companies

Section C: Social, socio-economic

Which issues of the following table do you consider important: 1 (the least important), 5 (the most important):

Importance means: which socio-economic issues are important to be included in EUCalc, to answer the most urgent questions of targeted users. In other words, which issues are important in order to show the impact of the choices that can be made by citizens and sectors?

Social and socio-economic issues	**[1] the least important**	**[2] Very unimportant**	**[3] Neither important nor unimportant**	**[4] Very important**	**[5] the most important**	**I don´t know**

Social and socio-economic issues	**[1] the least important**	**[2] Very unimportant**	**[3] Neither important nor unimportant**	**[4] Very important**	**[5] the most important**	**I don´t know**
Working conditions	[1]	[2]	[3]	[4]	[5]	
Labor rights	[1]	[2]	[3]	[4]	[5]	
Employment	[1]	[2]	[3]	[4]	[5]	
Training and education	[1]	[2]	[3]	[4]	[5]	
Equity	[1]	[2]	[3]	[4]	[5]	
Human health and safety	[1]	[2]	[3]	[4]	[5]	
Cultural diversity	[1]	[2]	[3]	[4]	[5]	
Food security	[1]	[2]	[3]	[4]	[5]	
Energy security	[1]	[2]	[3]	[4]	[5]	
Social cohesion	[1]	[2]	[3]	[4]	[5]	
Standard of living	[1]	[2]	[3]	[4]	[5]	
Property rights	[1]	[2]	[3]	[4]	[5]	
Social development	[1]	[2]	[3]	[4]	[5]	
Suggested extra issues by respondents. If there are any issues or are issues which we did not include them in the table please mention in the empty rows below.						

Social and socio-economic issues	**[1] the least important**	**[2] Very unimportant**	**[3] Neither important nor unimportant**	**[4] Very important**	**[5] the most important**	**I don´t know**

Do you wish to receive the reports of the current study (including survey results)?

☐ **Yes**

☐ **No**

List of participants in the workshop

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13. Miguel Hernandez, Director of Bonsucro Latin America
14. Luísa Schmidt, Professor institute of Social Sciences in University Lisbon
15. Dilip Khatiwada, associate professor, Energy and Climate Studies, KTH Royal Institute of Technology, Sweden
16. Fruzsina Homolka, current employee of World Business Council for Sustainable Development, participated as an independent expert

17. Leonie Dendler, German Federal Institute for Risk Assessment, participate as an independent expert
18. Kornelis Blok, founder and Director of Science at Ecofys and Professor Energy Systems Analysis at Delft University of Technology
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27. Alessandra Prampolini, T6
28. Michel Cornet, Climact
29. Adrian Taylor (facilitator), 4Sing
30. Jonathan Buhl (Co Facilitator), 4Sing