MENA SELECT

Project: **M**iddle **E**ast **N**orth **A**frica **S**ustainable **ELEC**tricity **T**rajectories (**MENA-SELECT**)

SUPPLEMENTAL MATERIAL

Energy for the Future

Evaluating different electricity generation technologies against selected performance characteristics and stakeholder preferences: Insights from the case study Morocco

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1 ANNEX 1 - SUMMARY OF STAKEHOLDER VISIONS

Economy:

\ **Green growth:** Balancing environmental sustainability along its projected growth trajectory through ambitious renewable energy and climate smart policies were acknowledged by all stakeholder groups as a crucial element to generate more jobs, economic value and upgrade the workforce in the mid- to long term in Morocco.

\ **Energy security:** The availability and access to affordable and sufficient electricity supply was regarded by all stakeholder groups as a key component for achieving sustainable growth rates, industry competiveness and overcoming energy poverty in remote rural areas.

\ **Poverty eradication:** Alleviating poverty and its root causes, such as high illiteracy rates, volatile economic growth, high levels of informal employment and uncertainty around future remittances, should be one of the major national goals to be reached by 2050 according to all stakeholder groups.

\ **Economic competitiveness:** Increased net productivity gains in high value-added sectors were mentioned as paramount ingredients by all stakeholders to overcome the kingdom's structural orientation toward non-tradeable and labor-intensive activities, such as construction, public works, and low value-added agricultural production. Furthermore "Finance and Industry" underscored that investments in better quality of education and labor market reforms would be required as means to decrease the high price of the national export basket and allow Moroccan companies to compete on the global market.

\ **Attractive business environment:** As the industrial sector is relatively more open than other sectors to advancements in technology and knowledge transfer "Finance and Industry", "National NGOs", "Policy-makers" and "Academia" highlighted that Morocco's low wages, young workforce and geographical position should be capitalized to transform the country into a manufacturing hub for European and African markets. In particular "Finance and Industry" envisioned that increased foreign direct investments into measures to diversify the economy and to shift workers from low to high productivity sectors would help boost urgently needed employment, high value-added exports and GDP growth, while narrowing the current national trade deficit.

\ **Import independence:** With the economic value of its main imported products outweighing the value of its main exports, "Finance and Industry", "National NGOs", "Policy-makers" and "Academia" pointed out that they would like to see

Morocco decrease its import dependence especially with regards to costly fossil energy and high added-value commodities, such as electrical equipment, vehicles and machinery. This would not only make the country more resilient against global market fluctuations and decrease its energy bill but enable the *GoM* to shift more of the national budget towards education, health care and infrastructure development.

Society:

\ **Social justice:** Equal distribution of and non-discriminatory access to opportunities, resources and legal rights - in particular for the least advantaged members of the Moroccan society - were highlighted by all stakeholders as prerequisites upon which a healthy society in Morocco should be built. Issues identified in regards to social justice included inclusive access to basic services such as education, medical care, and health insurance, but also employment, property and the capacity of citizens to defend their legal rights.

\ **Participatory governance:** Enhanced access to transparent information on matters that affect people's lives, deepened channels for citizen engagement in policy-making processes and improved accountability in the legal framework were considered by "Policy-makers", "Academia", "Young Leaders" and "Finance and Industry" as effective means for making governmental spending more responsive to the needs of Moroccan citizens. Additionally, "National NGOs" underscored the importance of civil society organizations and trade unions in formulating, implementing and monitoring public policies geared towards sustainable development, whereas "Local Communities" hoped for new political relationships between public and community stakeholders as well as increased decentralization efforts.

\ **Solidarity:** All stakeholder groups underlined the importance of social solidarity among the Moroccan citizens to overcome existing social challenges in the upcoming decades. Yet, social solidarity was not discussed as social assistance or providing charity to the needy, but rather as a prerequisite of social cohesion that should be formalized in corresponding policies.

\ **Knowledge and education:** All stakeholder groups acknowledged the importance of progress towards free access to higher levels of education and access to information for all as fundamental to a modern society and as important to raise environmental awareness. Furthermore, freedom of opinion and expression was discussed as a basic element for transforming an information-based into a knowledge-based society that fosters innovation and embraces diversity of thinking.

\ **Quality of life and safety:** Enhanced wellbeing and improved access to basic livelihood services, such as potable water, electricity, sanitary facilities, adequate

housing, education, transportation and health care were emphasized in the visions of "National NGOs", "Local Communities" and "Policy-makers".

Environment:

\ **Protection of natural resources:** All stakeholder groups mentioned that Morocco's future development depends to a large extent on whether the pressure on natural resources can be reduced and whether the state of water bodies, habitats, forests and air quality can be improved so that these resources are available for the future use on a sustainable basis.

\ **Conservation of biodiversity:** The recovery and maintenance of Morocco's marine and terrestrial wildlife and flora in particular through the establishment of more protected areas and the implementation of a sound rehabilitation management system were underscored by all stakeholder groups.

\ **Resilience to climate-induced threats:** As climate-induced trends point towards further decreasing precipitation, increasing temperatures, more extreme weather events and declining water resources, all stakeholder groups agreed that the sake of Morocco's environmental health depends on the country's and its communities' capacities to adapt to and recover from future climate change impacts.

\ **Environmental regulations:** Stronger environmental regulations and more efforts to harmonize their enforcement through dedicated institutions were identified by all stakeholder groups as key to manage domestic environmental challenges, such as land degradation, deforestation, desertification, contamination of water supplies and air pollution.

2 ANNEX 2 - SUMMARY OF STAKEHOLDER ASPIRATIONS AND CONCERNS

Economy: When asked about how electricity generation technologies could either hamper or foster the achievement of their vision towards green growth, poverty eradication, economic competitiveness and an attractive business environment as well as import independence, similarities among stakeholder groups were found on the following elements.

Green growth

- Ý Share of RE in the electricity mix: All stakeholder groups considered high shares of RE in the electricity mix the backbone of green growth.
- Þ Maturity of technologies: "Policy-makers", "Academia" and "Finance and Industry" raised concerns about economic risks stemming from potential lock-in effects and uncertainties in regards to the maturity of deployed electricity technologies. On the one hand, stakeholders worried that investments in already mature fossil technologies could result in both significant opportunity costs due to learning curve effects of RE technologies and real fiscal burden in case of stricter environmental regulations aiming to internalize harmful externalities (e.g., carbon price). On the other hand, the three stakeholder groups were anxious about possible uncertainties in cost forecasts and decisive learning curves of RE technologies that could lead to expensive non-competitive technology choices in the long-term (e.g., in the case of CSP).

Energy security

- Ý Stability and reliability of the energy carrier: "Policy-makers", "Academia" and "Finance and Industry" stakeholders were optimistic that investments into new electricity capacities with increasing shares of volatile renewable sources would improve the existing grid infrastructures, storage and balancing capacities between supply and demand and distributed electricity generation thereby reducing the risk of power failures that have shut down production at companies and critical infrastructures (e.g., water supplies, hospitals, transportation) in the past.
- Þ Affordability of electricity prices: All stakeholder groups worried about the affordability of electricity prices because of high-up front costs of RE technologies, sunken costs and uncertainties about future prices of fossil technologies and increasing balancing costs at high shares of RE.

Poverty eradication

- Ý Employment and income opportunities: Job creation and increased economic purchasing power were associated by all stakeholder groups with investments into new electricity infrastructures.

Economic competitiveness:

- Ý Industry integration: As the Moroccan economy still remains orientated towards non-tradable and labor intensive activities, all stakeholder groups aspired that the deployment of new electricity capacities would increase the productivity of Small and Medium Enterprises (SMEs) in high added-value services, thereby decreasing the country's dependence on agricultural production.
- Þ Absorptive capacities in domestic industries: The low level of human capital and slow technical progress in the industry sector left all stakeholder groups except "Local Communities" in doubt whether Morocco could really benefit from knowledge and technology and avoid a new form of import dependency that would substitute fossil fuel dependency with reliance on imports of RE technologies.

Attractive business environment

- Ý Foreign direct investments: Given Morocco's comparative political stability, economic resilience, improving business environment and strategic geographic position, "National NGOs", "Finance and Industry", "Policy-makers" and "Academia" associated increasing foreign direct investments with the development of new electricity capacities. In this context "Policy-makers" highlighted that clear energy and climate targets and the country's reputation as a climate and RE posterchild would result in new opportunities to attract foreign development and climate finance as loans and grants in the field of RE.
- Ý Economic participation in electricity generation: Participants from "Finance and Industry", "Academia" as well as "Policy-makers" were confident that the political commitment for RE in Morocco would expand the eligibility for selling surplus electricity to producers connected to the medium- and low-voltage grid as well as expand the current cap of 20 per cent surplus which is allowed to be fed into the high and very high voltage grid, thereby enabling self-producers and small and medium-sized investors to economically participate in electricity generation.
- Þ Policy coherence: Participants of "Finance and Industry", "Academia", "National NGOs" and "Policy-makers" perceived existing sectoral fragmentation and silo approaches at the governmental level a significant challenge

for harmonizing the often non-convergent interests and the institutional and policy level in the field of energy and development.

Import Independence

- Use of domestic energy to improve national balance of trade: International collaboration in the exploration and utilization of domestic energy sources was associated by "National NGOs", "Academia", "Finance and Industry" and "Policy-makers" with a positive balance of trade due to a) new export opportunities in the field of energy and electricity (oil shales on the world market and RE to Europe, Algeria and Mauritania) as well as high-added value technology components (e.g., CSP and wind), and b) a decreased energy dependence on costly energy imports.
- Diversification and regionalization of the electricity system: The utilization of domestic energy sources through the increased deployment of RE and natural gas as well as the interconnectedness with adjacent energy markets (e.g., Spain, Algeria and Mauritania) was seen by almost all stakeholder groups as an opportunity to diversify the country's national energy mix and increase its resilience towards global market fluctuations and the internal risks of power shortages. An exception was marked by "Local Communities" who did not mention this issue.
- Vulnerability to global energy price fluctuations: With global energy prices of fossil energy carriers having become highly volatile over the years, "Finance and Industry", "Policy-makers" and "Academia" expressed concerns that the reliance on imported fossil energy carriers from a only a handful of countries could increase Morocco's vulnerability toward price fluctuations of the world energy market as well as create uncertainties in regards to reliable energy supplies and thereby have far-reaching effects on the economy, the trade balance and living standards.

Society: When asked about how electricity generation technologies could either hamper or foster the achievement of their vision towards an society based on social justice, participatory governance, solidarity, knowledge and a high quality of life, similarities among stakeholder groups were found on the following elements.

Social justice

- Fairness and equality in energy planning: With the exception of "Policy-makers" and "Finance and Industry", all stakeholder groups hoped that the deployment of new electricity capacities would be accompanied by new legislations geared towards a more equal distribution of benefits and compensation of harmful effects among affected stakeholders at the project level - but also among society in general.

- Þ Elite capture: Although the deployment of new electricity capacities was considered generally as a promising path to poverty eradication and distributed prosperity, critique centered on the potential susceptibility of electricity planning to elite capture. "National NGOs" and "Local Communities" stakeholders worried that economic benefits and decision-making processes could be captured by the self-interests of elites and to the detriment of the broader society - with already marginalized groups being particularly affected by further economic exclusion.
- Þ Social divide: "Young Leaders", "Local Communities", and "National NGOs" raised concerns that the installation of electricity generation facilities in rural and/or marginalized areas and the potential for electricity-intensive industries to locate in their vicinity could further amplify the already existing social divide among different social groups and intensify rural exodus in various geographic regions - particularly if the electricity and economic revenues generated are transported to distant consumption and economic centers.

Participatory governance

- Ý Political participation: The roll-out of new electricity generation capacities was associated by all stakeholders with the unique opportunity to depart from the largely technocratic top-down driven policy structures and institutionalize a new democratic approach in energy planning geared towards a more inclusive and participatory agenda setting as well as decision-making.
- Þ Transparency and political exclusion: All stakeholder groups but "Policy-makers" were anxious that investments in new electricity generation capacities would be decided up-front by centralized governmental institutions without the inclusive and informed consultation of affected and interested stakeholder groups.

Solidarity

- Ý National pride: Especially the country's RE ambition and Morocco's international reputation as a global forerunner in sustainable energy planning was hoped by "National NGOs", "Finance and Industry", "Young Leaders" and "Policy-makers" to bring society together to reach the common goal of green growth.
- Þ Traditional lifestyles and social cohesion: The installation of new electricity generation technologies was feared by "Local Communities" and "National NGOs" to deteriorate the social cohesion among the Moroccan society due

to differing technology preferences (opponents and supporters of technology choices) and competition over benefits.

Knowledge and education

- Ý Technology and knowledge transfer: Growing domestic innovation capacity (R&D) and new avenues for technology and knowledge transfer through international cooperation in the electricity sector were wished for by all stakeholder groups. Additionally, all stakeholder groups had high hopes that investments in new electricity generation capacities would be accompanied with corresponding educational policies that connect basic education, vocational training and university as well as be aligned within an industrial development strategy to develop the country's skill base required to increase both the quantity and the productivity of labor employed in the economy.
- Ý Environmental awareness: The country's move towards green growth and the deployment of additional RE generation capacities were aspired by all stakeholder groups to raise public awareness on environmental problems, including climate change, as well as encourage more sustainable consumption patterns and lifestyles.
- Þ Science-industry cooperation: Although links between higher education institutions and businesses were regarded pivotal for encouraging knowledge and technology transfer, driving innovation and increasing the productivity of the domestic workforce, almost all stakeholder groups were concerned that low levels of science-industry cooperation in Morocco would hinder the development of a more skilled and knowledgeable workforce, innovation and future capacity for economic growth. An exception was marked by "Local Communities" who did not mention this issue.
- Þ Mismatch of skills and competencies: The structural mismatch between the educational qualifications of job-seekers and the profiles sought on the labor market left all stakeholder groups question whether the development of new electricity infrastructures would break the vicious circle of low education, low productivity and low income and thereby result in high quality and long-term employment prospects - especially for the youth.

Quality of life and safety

- Ý Rural infrastructure and services: "National NGOs", "Local Communities" and "Finance and Industry" expected new electricity generation capacities to become drivers for infrastructural improvements in the vicinity of power plants due to increased economic activity and demand for electricity, water

and sanitation, waste management, health care, transportation and telecommunication.

- Landscape aesthetics and scenic attractiveness: "National NGOs", "Local Communities" and "Finance and Industry" worried that the visibility of electricity generation facilities (e.g., cooling towers, wind turbines, transmission lines etc.) would have negative repercussions on the aesthetics, natural beauty and scenic value of the surrounding landscape - in particular in recreational, coastal and touristic areas.
- Noise pollution: While most of the stakeholder groups seemed to not be troubled by the noise impacts stemming from power plants, "Local Communities" and "National NGOs" raised concerns that either excessive amounts of noise or an unpleasant sound stemming from electricity generation facilities could results in increased levels of psychological distress and adverse health impacts in adjacent communities.
- Technology risk: As electricity generation capacities expand and new technologies are being introduced to Morocco (e.g., CSP, nuclear) "National NGOs", "Local Communities", "Academia" and "Policy-makers" raised concerns about increasing risks of severe off-normal accidents resulting from either technology failure or human error due to the low preparedness of national institutions in handling high-risk technologies and applying adequate emergency response plans.

Environment: When asked about how electricity generation technologies could either hamper or foster the achievement of their vision towards an healthy environment based the protection of natural resources, conservation of biodiversity, resilience to climate change and environmental regulations, similarities among stakeholder groups were found on the following elements.

Protection of natural resources

- Water security: As water is indispensable for electricity generation, all stakeholder groups regarded the water-energy nexus pivotal for achieving their vision although with ambivalent considerations. On the one hand, the water consumption of power plants was worried to compete with the water demands of the population and potentially result in social conflict either by reducing the available water supplies or the quality of water bodies due to thermal pollution caused by the excess heat of power plants. One the other hand, technological efficiency gains (e.g., dry cooling in CSP), low-water consuming technologies (e.g., wind and PV) and new technological applications (cogeneration with desalination plants, solar-water pumping

systems) were hoped to improve the water-footprint of the electricity sector to acceptable levels.

- Air pollution: All stakeholder groups related air pollution and its impacts on health to the deployment of electricity generation technologies. However, while they all worried that air quality and adverse effects on human health could worsen especially in the vicinity of fossil power generation, "National NGOs" and "Academia" hoped that high shares of RE and the application of new abatement techniques for fossil technologies would improve the country's air quality - especially in highly industrialized, urban regions.
- Land use: Land requirements of power generation technologies were associated by "Local Communities" and "National NGOs" with possible ramifications for the livelihood security of local communities stemming from potentially negative interference with land rights and subsistence land use.
- Waste: Almost all stakeholder groups highlighted their concerns that the operation of new electricity generation technologies would result in the disposal of hazardous waste that if leaked into the environment could cause significant negative consequences on ecosystems and human health. One exception was marked by "Policy-makers" who were optimistic that better recycling techniques would increase the efficiency of electricity generation and reduce its hazardous by-products to acceptable levels.

Conservation of biodiversity

- Reforestation and regeneration of vegetation: "Policy-makers", "Academia" and "National NGOs" hoped that new electricity generation capacities would be used to power desalination plants in order to prevent further desertification by measures of reforestation and regeneration of vegetation cover.
- Land degradation and biodiversity: "National NGOs" and "Local Communities" worried about potential impacts on essential ecosystem services as well as the flora (seed variety) and fauna (breeding grounds, migration of birds) stemming from the clearance of power plant sites and possible environmental pollution into the soils and groundwater aquifers.

Resilience to climate-induced threats

- Greenhouse gas (GHG) emissions: Being severely affected by the impacts of climate change, participants across all stakeholder groups considered GHG

emissions in electricity generation a crucial element towards fighting climate change and achieving green growth.

- Climate resilience of technologies: "Academia", "Local Communities" and "National NGOs" raised concerns that higher air and water temperatures as well as decreased water availability caused by the accelerated changes in the climate could put the performance and efficiency of power plants and thus the security of electricity supply at risk.

Environmental regulations

- Environmental regulations: All stakeholder groups mentioned that the expansion of electricity generation capacities could either lead to stricter environmental regulations and their enforcement due to the increasing environmental footprint of the energy sector on natural resources or to a lowering of environmental standards in order to attract foreign direct investments ("race to the bottom").

3 ANNEX 3 - ILLUSTRATIVE INDIVIDUAL STAKEHOLDER GROUPS' WEIGHTS AND COMPROMISE SOLUTION

Criteria ranking - Policy-makers						Weight	Importance category based on weights	Importance category based on number of ranks
		Use of domestic energy sources	Technology and knowledge transfer	Global warming potential		13.95	high	high
Domestic value chain integration	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Electricity system costs	Local air pollution and health	8.14	moderate – least	moderate
			On-site job creation	Safety		4.65	least	least

Figure 1: Ranking result, calculated weights and importance categories for the group of "Policy-makers".

Criteria ranking - F&I		Weight	Importance category based on weights	Importance category based on number of ranks
	Use of domestic energy sources	23.38	high	high
	Electricity system costs	16.48	high – moderate	high – moderate
	(White card)			
	(White card)			
Pressure on local water security	Safety	9.78	moderate – low	moderate
Domestic value chain integration	Technology and knowledge transfer	8.33		
On-site job creation	Local air pollution and health	6.99		
	Global warming potential	5.71	least	moderate – low
	(White card)			
	(White card)			
Pressure on land resources	Non-emission hazardous waste	2.13	least	least

Figure 2: Ranking result, calculated weights and importance categories for the group of "Finance and Industry".

Criteria ranking - Academia			Weight	Importance category based on weights	Importance category based on number of ranks
	Use of domestic energy sources		21.23	high	high
Technology and knowledge transfer	Pressure on local water security	Domestic value chain integration	14.74	high - moderate	
	(White card)				
	(White card)				
	On-site job creation		8.02	moderate – low	moderate
Electricity system costs	Non-emission hazardous waste	Safety	6.49		moderate – low
	(White card)				
	(White card)				
Local air pollution and health	Pressure on land resources	Global warming potential	2.36	least	least

Figure 3: Ranking result, calculated weights and importance categories for the group of "Academia".

Criteria ranking - Young leaders			Weight	Importance category based on weights	Importance category based on number of ranks
Use of domestic energy sources	Electricity system costs	Technology and knowledge transfer	15.09	high	high
Pressure on local water security	Non-emission hazardous waste	Safety	9.43	moderate	moderate
Local air pollution and health	Pressure on land resources	Global warming potential	6.29	moderate – low	
	Domestic value chain integration	On-site job creation	3.77	least	least

Figure 4: Ranking result, calculated weights and importance categories for the group of "Young leaders".

Criteria ranking - Local communities				Weight	Importance category based on weights	Im-portance category based on number of ranks
		Pressure on local water security		20.73	high	high
		(White card)				
Global warming potential	Technology and knowledge transfer	Pressure on land re-sources	Electricity system costs	10.36	moderate	moderate
	Safety	Use of domestic energy sources	On-site job creation	7.77	moderate – low	
		Domestic value chain integration	Local air pollution and health	5.53	least	moderate – low
		Non-emission hazardous waste		3.45		least

Figure 5: Ranking result, calculated weights and importance categories for the group of "Local communities".

Criteria ranking - NGOs			Weight	Importance category based on weights	Importance category based on number of ranks
	Pressure on local water security		29.44	high	high
	(White card)				
	(White card)				
	Use of domestic energy sources		14.38	moderate	high – moderate
	Pressure on land resources		12.31	moderate - low	moderate
	(White card)				
	(White card)				
Non-emission hazardous waste	Technology and knowledge trans-fer	Local air pollution and health	7.19	least	moderate – low
Domestic value chain integration	Global warming potential	Safety	5.65		
	(White card)				
	On-site job crea-tion	Electricity system costs	2.68	least	least

Figure 6: Ranking result, calculated weights and importance categories for the group of "National NGOs".

Criteria ranking - Compromise solution			Weight	Importance category based on weights	Importance category based on number of ranks
Use of domestic energy sources	Technology and knowledge transfer		16.62	high	High
Pressure on local water security	Domestic value chain integra-tion		11.08	high – moderate	high – moderate
Electricity system costs	Global warming potential	On-site job creation	8.31	moderate	moderate
Pressure on land resources	Local air pollu-tion and health		6.23	moderate – low	
	Safety		4.43	least	moderate – low
	Non-emission hazardous waste		2.77		least

Figure 7: Ranking result, calculated weights and importance categories for the "compromise solution".

Criteria ranking – additionally developed ranking			Importance category based on number of ranks
Use of domestic energy sources			high
Pressure on local water security			high – moderate
Technology and knowledge transfer			
Electricity system costs			moderate
Global warming potential	Domestic value chain integration		moderate – low
Pressure on land resources	Local air pollution and health	Safety	
Non-emission haz-ardous waste	On-site job creation		least

Figure 8: Ranking result and calculated weights for the ranking based on ranking categories.

	Difference in ranking categories											
Compared groups	Use of domestic energy sources	Global warming potential	Domestic value chain integration	Technology and knowledge transfer	Electricity system costs	On-site job creation	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Local air pollution and health	Safety	**Cumulative**
PM-FI	0	3	0	2	2	2	2	0	2	0	2	**15**
PM-AC	0	4	2	0	1	2	2	2	1	2	1	**17**
PM-YL	0	2	2	0	2	0	0	0	0	0	2	**8**
PM-NGOs	1	3	1	3	2	0	0	2	1	1	1	**15**
PM-LC	2	2	1	2	0	2	0	2	2	1	2	**16**
FI-AC	0	1	2	2	3	0	0	2	1	2	1	**14**
FI-YL	0	1	2	2	0	2	2	0	2	0	0	**11**
FI-NGOs	1	0	1	1	4	2	2	2	1	1	1	**16**
FI-LC	2	1	1	0	2	0	2	2	0	1	0	**11**
AC-YL	0	2	4	0	3	2	2	2	1	2	1	**19**
AC-NGOs	1	1	3	3	1	2	2	0	0	1	0	**14**
AC-LC	2	2	3	2	1	0	2	0	1	1	1	**15**
YL-NGOs	1	1	1	3	4	0	0	2	1	1	1	**15**
YL-LC	2	0	1	2	2	2	0	2	2	1	0	**14**
NGOs-LC	1	1	0	1	2	2	0	0	1	0	1	**9**

Table 1: Comparison of differences in ranking categories between all stakeholder groups. The values marked red indicate that the two groups have the highest possible difference with regard to the criterion above.

Rationale behind importance categories based on rank positions

In order to categorize the criteria into five importance categories based on their rank position within the ranking, the following points were considered:

\ The categorization of the criteria into five categories of importance (i.e., "high importance", "high to moderate importance", "moderate importance", "moderate to low importance", and "least importance") should not be connected to the weights calculated with the CAR method. Instead it should be solely grounded in the number of ranks as any mathematical categorization using the surrogate weights would connect the categories again to weights that have not directly been stated by the participants.

\ As it was the task during the "silent negotiation" to rank the criteria from "highest" to "least" importance, one can assume that the rank on top / bottom has always to be in the category "high / least importance". Additionally, the rank / ranks in the middle of the ranking should be of "moderate importance".

\ For an odd number of ranks the median has always to be in the "moderate importance" category (e.g., for five ranks the median is three; hence, rank number three has to be of "moderate importance") and for an even number of ranks the two ranks above / below the median have to be in the category "moderate importance" (e.g., for six ranks the median is 3.5; hence rank number three and four

have to be of "moderate importance" as these ranks are "in the middle" of the ranking).

\ The ratio between the importance categories should not be larger than 2:1, because this would mean that an importance category is over-proportionally represented within the ranking. For example, in the case of seven ranks one could expand the category "moderate importance" above / below rank number four. This would result in three ranks for the category "moderate importance", but only one rank for the category "high / least importance". Even if the "high / least importance" categories would be expanded each by one additional rank, the categories "high to moderate / moderate to low importance" would fill only one importance category.

\ Starting from the "moderate importance" category the ranks above / below should be filled with the categories "high to moderate / moderate to low importance" until the ranking is filled. In cases where this will violate the ratio rule above, the "high / least importance" categories have to be expanded.

\ For individual group rankings that resulted in a number of ranks that is less than five, only the categories "high importance", "moderate importance", and "least importance" are applicable.

4 ANNEX 4 - DETAILED CRITERIA RANKINGS

Stakeholders	Use of domestic energy sources	Global warming potential	Domestic value chain integration	Technology and knowledge transfer	Electricity system costs	On-site job creation	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Local air pollution and health	Safety
Young Leaders	15.09	6.29	3.77	15.09	15.09	3.77	6.29	9.43	9.43	6.29	9.43
National NGOs	14.38	5.65	5.65	7.19	2.68	2.68	12.31	29.44	7.19	7.19	5.65
Local Communities	7.77	10.36	5.53	10.36	10.36	7.77	10.36	20.73	3.45	5.53	7.77
Academia	21.23	2.36	14.74	14.74	6.49	8.02	2.36	14.74	6.49	2.36	6.49
Finance/Industry	23.38	5.71	8.33	8.33	16.48	6.99	2.13	9.78	2.13	6.99	9.78
Policy-makers	13.95	13.95	8.14	13.95	8.14	4.65	8.14	8.14	8.14	8.14	4.65
Compromise	16.62	8.31	11.08	16.62	8.31	8.31	6.23	11.08	2.77	6.23	4.43
Mean	15.97	7.39	7.69	11.61	9.87	5.65	6.93	15.38	6.14	6.08	7.30
Standard deviation	5.12	3.75	3.52	3.14	4.78	2.05	3.80	7.59	2.56	1.85	1.89
Quantil 1 (25%)	14.06	5.67	5.56	8.84	6.90	3.99	3.34	9.52	4.21	5.72	5.86
Min	7.77	2.36	3.77	7.19	2.68	2.68	2.13	8.14	2.13	2.36	4.65
Median	14.74	6.00	6.89	12.16	9.25	5.82	7.21	12.26	6.84	6.64	7.13
Mean	15.97	7.39	7.69	11.61	9.87	5.65	6.93	15.38	6.14	6.08	7.30
Max	23.38	13.95	14.74	15.09	16.48	8.02	12.31	29.44	9.43	8.14	9.78
Quantil 3 (75%)	19.69	9.34	8.28	14.54	13.91	7.58	9.81	19.23	7.90	7.14	9.02

Table 2: Detailed criteria rankings of the different stakeholder groups and the "compromise solution".

5 ANNEX 5 - DISPERSION DIAGRAMS OF INDIVIDUAL STAKEHOLDER GROUPS' WEIGHTS IN COMPARISON TO COMPROMISE SOLUTION

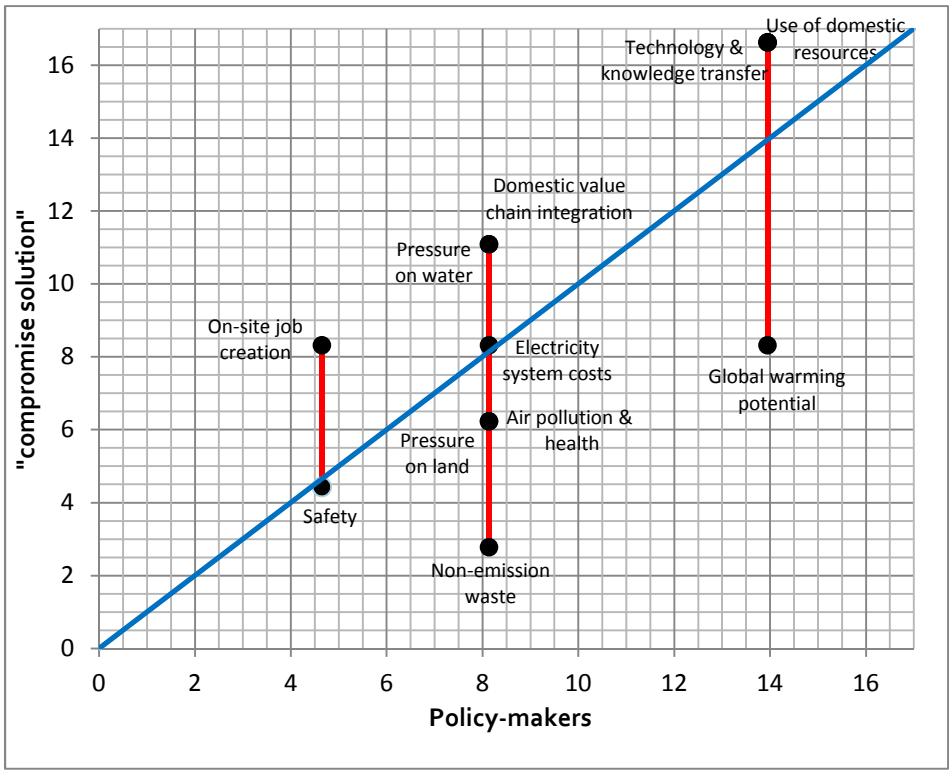

Figure 9: Dispersion diagram of the group "Policy-makers".

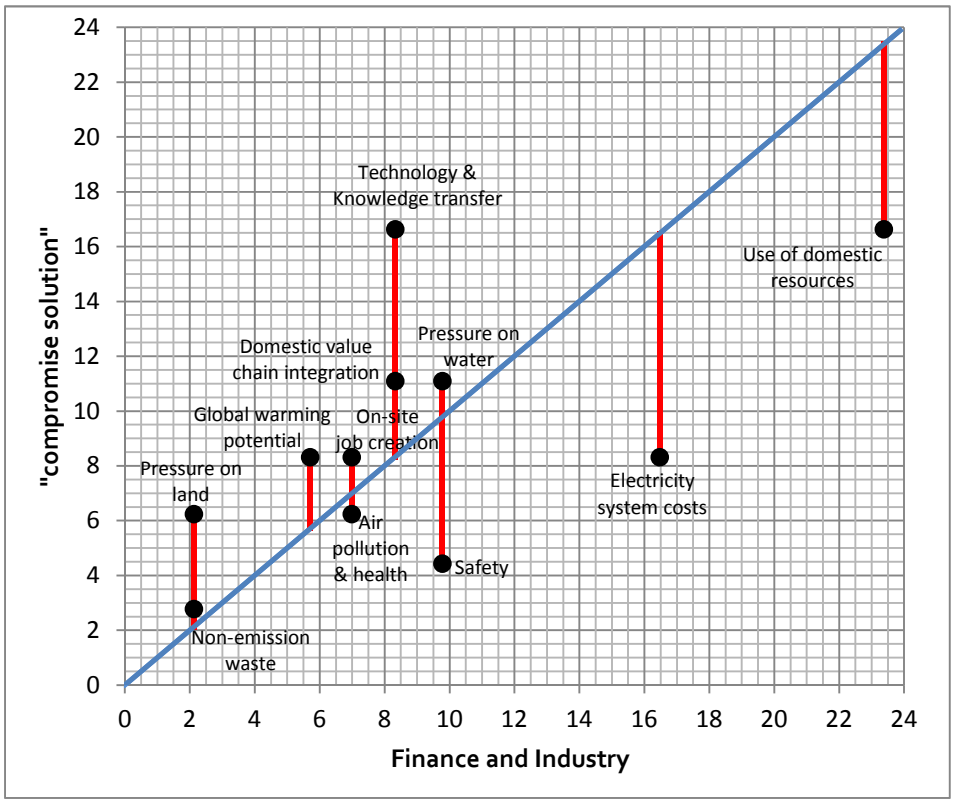

Figure 10: Dispersion diagram of the group "Finance and Industry".

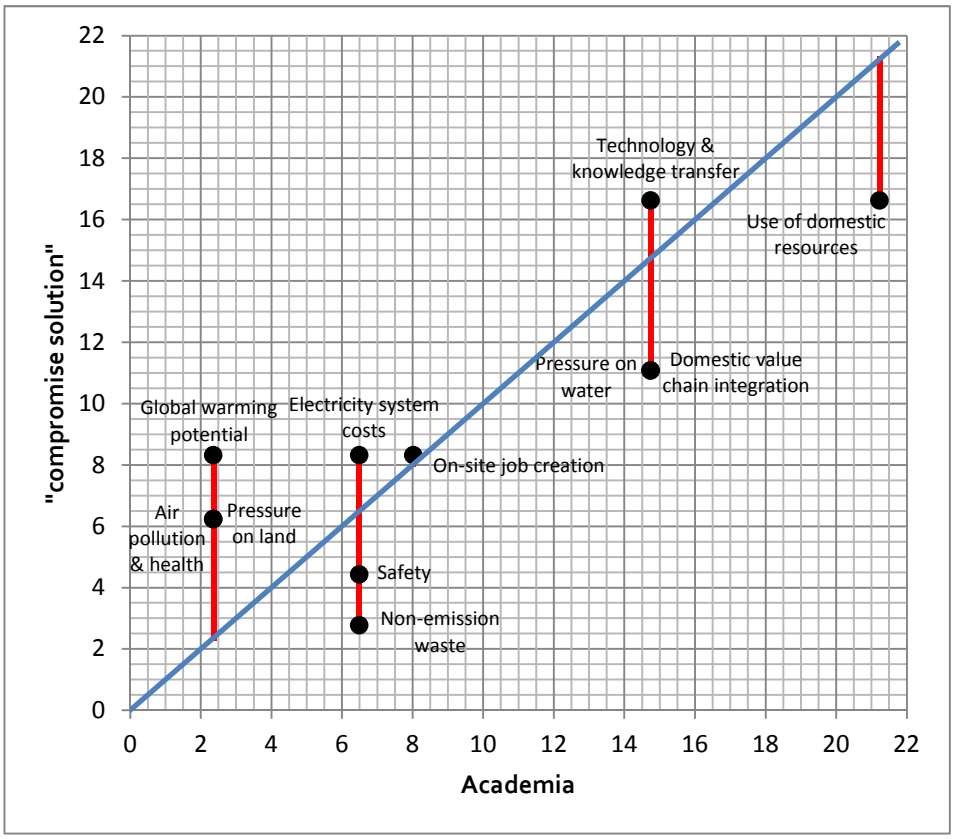

Figure 11: Dispersion diagram of the group "Academia".

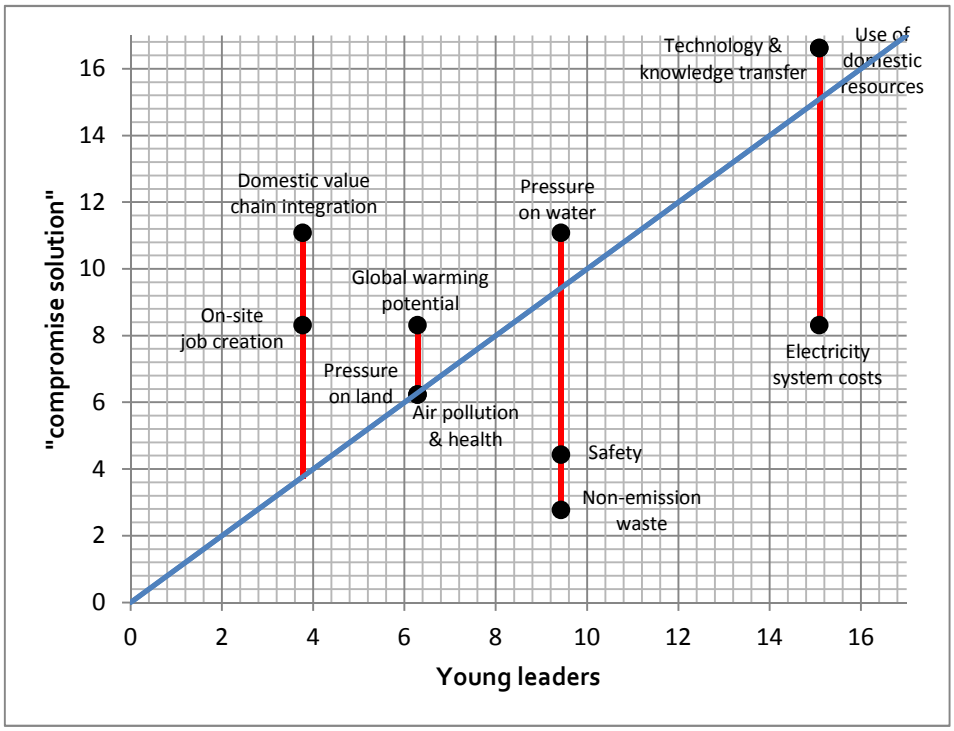

Figure 13: Dispersion diagram of the group "Young leaders".

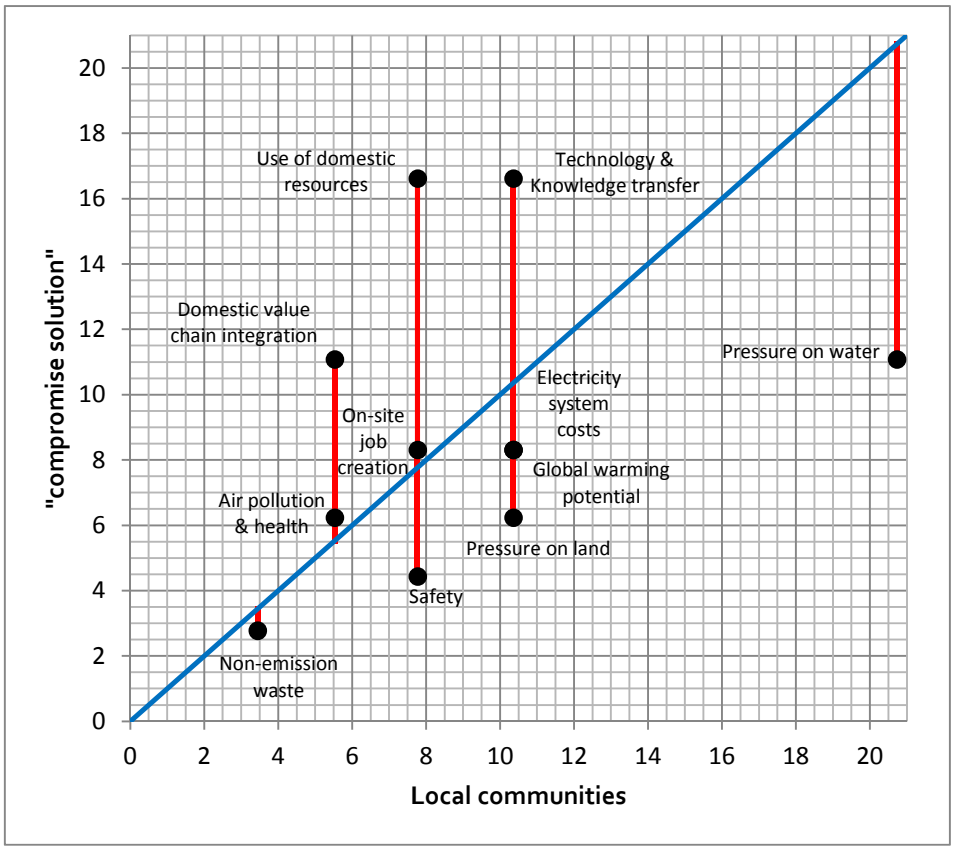

Figure 12: Dispersion diagram of the group "Local communities".

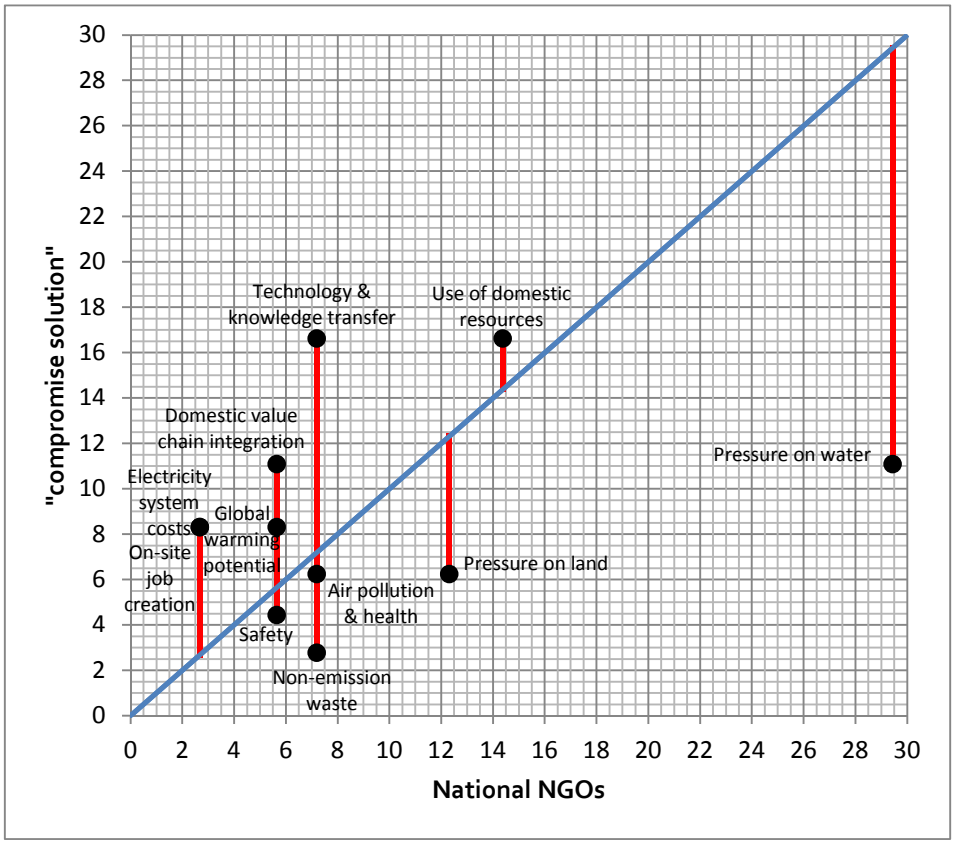

Figure 14: Dispersion diagram of the group "National NGOs".

6 ANNEX 6 – SENSITIVITY ANALYSIS

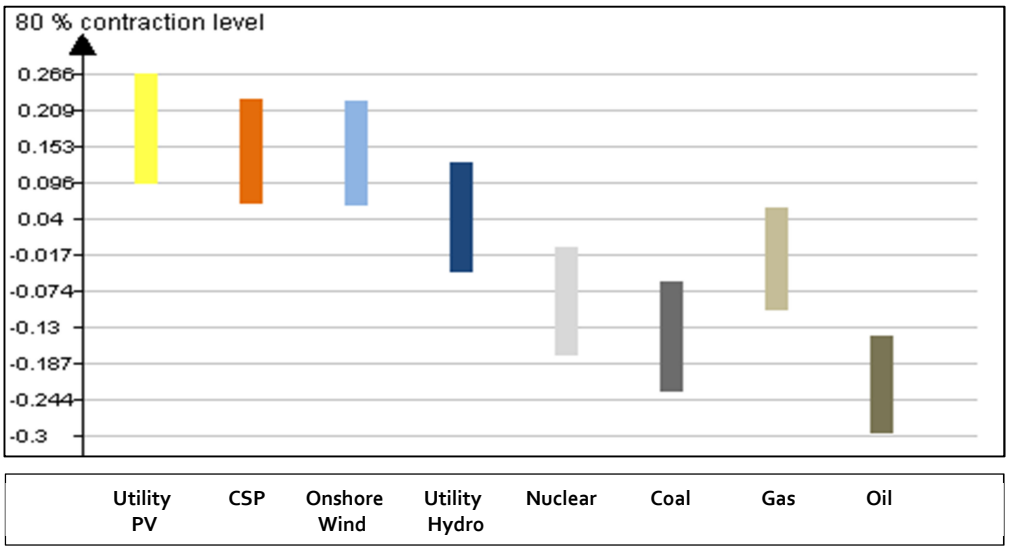

Figure 15: Cardinal ranking with a 80 per cent contraction level based on the weights of the "compromise solution".

Alternatives compared	Contraction intersection point	Confidence level
Utility PV > CSP	91.36	Not confident
Utility PV > Onshore wind	90.4	Not confident
Utility PV > Utility Hydro	74.37	Confident
Utility PV > Natural gas	60.81	Confident
Utility PV > Nuclear	58.55	Confident
Utility PV > Coal	47.02	Strongly confident
Utility PV > Oil	29.78	Strongly confident
CSP > Onshore wind	98.34	Not confident
CSP > Utility Hydro	79.41	Confident
CSP > Natural gas	64.6	Confident
CSP > Nuclear	61.01	Confident
CSP > Coal	48.96	Strongly confident
CSP > Oil	30.44	Strongly confident

Onshore wind > Utility Hydro	79.45	Confident
Onshore wind > Natural gas	64.3	Confident
Onshore wind > Nuclear	59.97	Confident
Onshore wind > Coal	47.2	Strongly confident
Onshore wind > Oil	27.49	Strongly confident
Utility Hydro > Natural gas	87.3	Mildly confident
Utility Hydro > Nuclear	75.44	Confident
Utility Hydro > Coal	65.11	Confident
Utility Hydro > Oil	45.91	Strongly confident
Natural gas > Nuclear	84.21	Mildly confident
Natural gas > Coal	75.48	Confident
Natural gas > Oil	57.18	Confident
Nuclear > Coal	91.93	Not confident
Nuclear > Oil	67.74	Confident
Coal > Oil	82.82	Mildly confident

Table 3: Pairwise comparison of all alternatives (confidence levels are based on the DecideIT software).

Criteria changed	Use of domestic energy sources	Global warming potential	Domestic value chain integration	Technology and knowledge transfer	Electricity system costs	On-site job creation	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Local air pollution and health	Safety	Sum
Global warming potential increase to 30	12.69	**30.00**	8.46	12.69	6.34	6.34	4.76	8.46	2.11	4.76	3.38	100.00
Electricity system cost increase to 30	12.69	6.34	8.46	12.69	**30.00**	6.34	4.76	8.46	2.11	4.76	3.38	100.00
Pressure on local water security increase to 30	13.08	6.54	8.72	13.08	6.54	6.54	4.91	**30.00**	2.18	4.91	3.49	100.00
Global warming potential decrease to 2	17.76	**2.00**	11.84	17.76	8.88	8.88	6.66	11.84	2.96	6.66	4.74	100.00
Electricity system cost decrease to 2	17.76	8.88	11.84	17.76	**2.00**	8.88	6.66	11.84	2.96	6.66	4.74	100.00
Pressure on local water security decrease to 2	18.32	9.16	12.21	18.32	9.16	9.16	6.87	**2.00**	3.05	6.87	4.88	100.00

Table 4: Weight changes of all criteria according to sensitivity analysis.

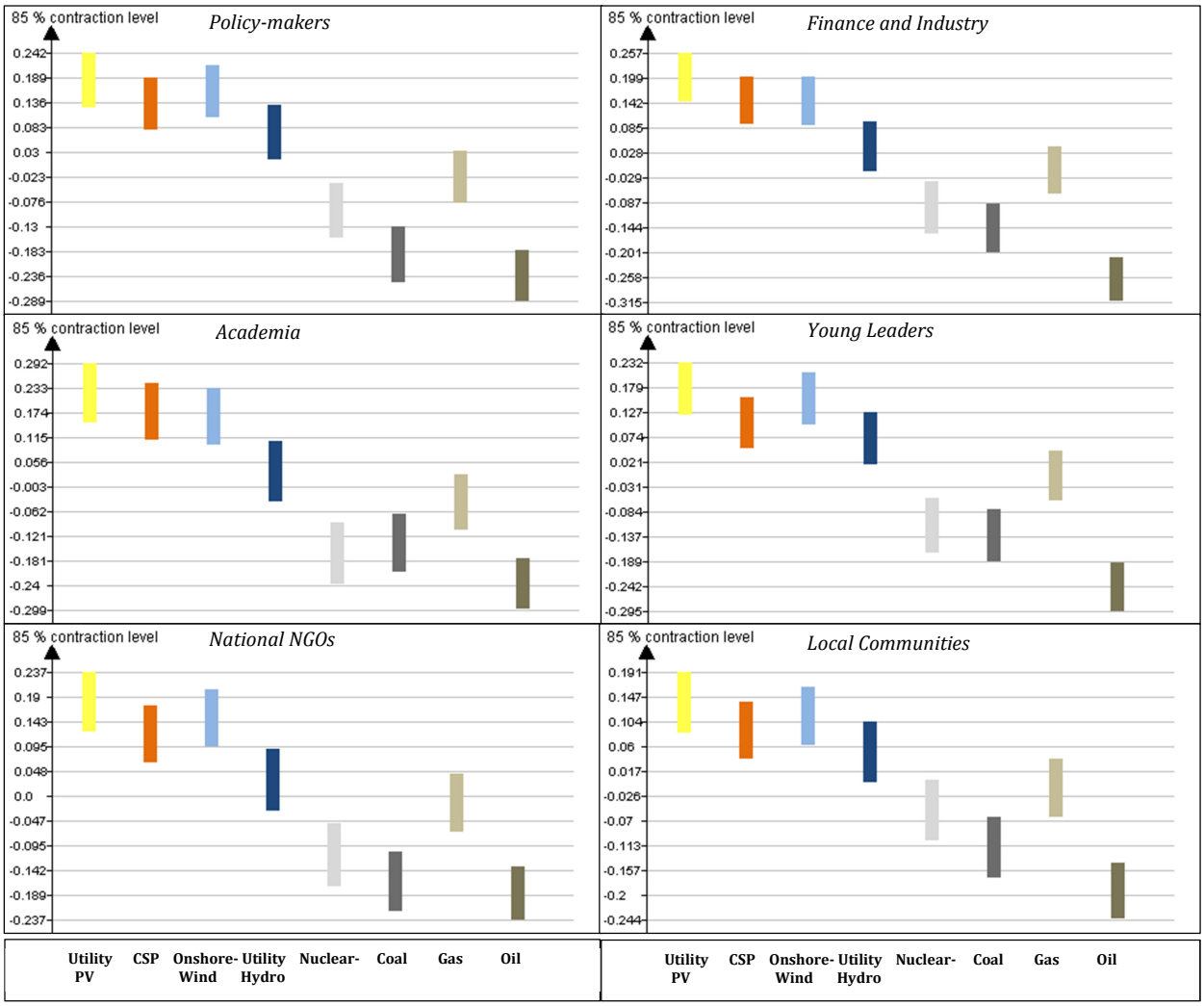

Figure 16: Results based on individual group weightings of all stakeholder groups.

7 ANNEX 7 – COMPARISON OF DIFFERENT AGGLOMERATION ALGORITHMS

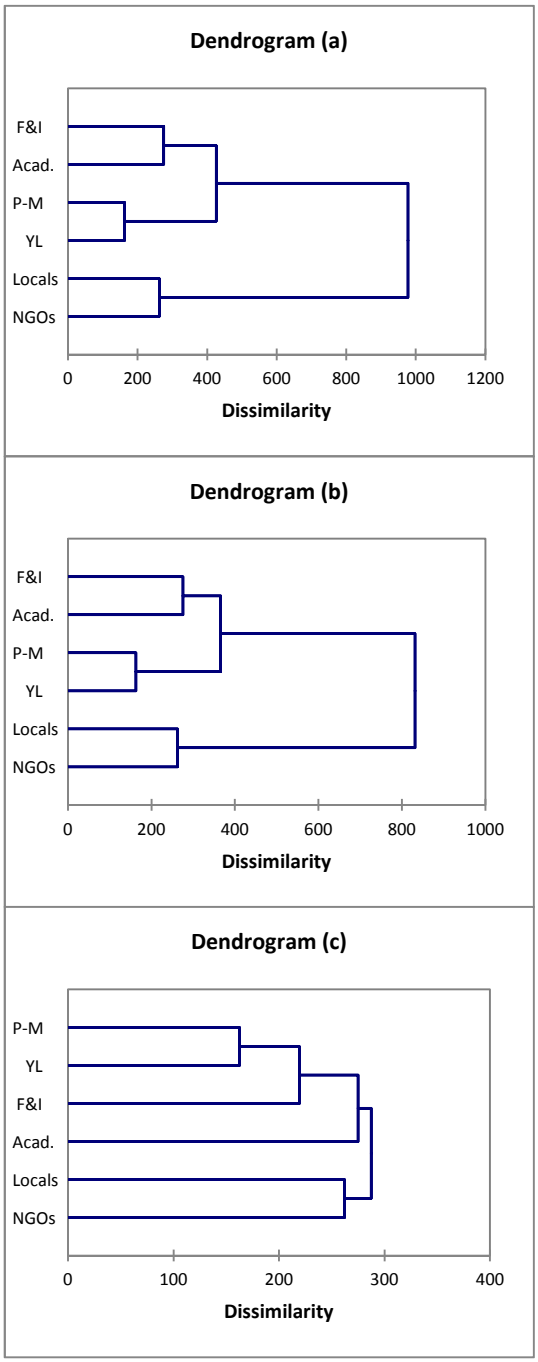

Figure 17: Hierarchical clustering analysis using Ward's method (a), complete linkage (b) and single linkage (c) for the 6 stakeholder groups and all 11 criteria.

There exist a number of agglomeration algorithms to combine clusters, such as, 'single linkage', 'complete linkage', or 'Ward's method' and others. It has been stated that 'single linkage', based on minimum distance, results in one larger cluster with the other clusters only contain few objects. 'Complete linkage', instead, is based on maximum distance and can be influenced by outliers. 'Ward's method' is one of the most commonly applied algorithms (Mooi and Sarstedt, 2011). Figures 16 a-c show the results of the cluster analysis using the three different agglomeration algorithms mentioned above for all six stakeholder groups and all 11 criteria. A comparison of the results of the three clustering analysis shows that clustering with 'Ward's method' and 'complete linkage' performs nearly identical: both algorithms put the groups of "Policy makers" and "Young Leaders" in the earliest cluster appearing (farthest to the left), meaning that those two groups have the lowest dissimilarities. The next cluster that appears is formed by "Local communities" and "National NGOs". The third cluster is formed by "Finance and Industry" and "Academia". Finally, a bigger cluster consisting out of "Finance and Industry", "Academia", "Policy makers" and "Young leaders" is formed before all stakeholder groups are merged into one cluster. Though, the usage of 'single linkage' also forms the first cluster "Policy makers" and "Young Leaders", but, in contrast to the others two algorithms, does not create a cluster consisting out of "Finance and Industry" and "Academia" next, but instead puts "Finance and Industry" together with the former cluster creating one cluster with three groups: "Policy makers" and "Young Leaders" and "Finance and Industry". In the next step, also the group of "Academia" is added to that cluster. In a last instance, "Local com-

munities" and "National NGOs" form one cluster separated from the other cluster.

As a whole, we found these results relatively similar and they also somehow stress the statement made above that 'single linkage' tend to result in one big cluster. Within all three algorithms "Policy makers" and "Young Leaders" form the first cluster meaning they have the least dissimilarities; and within all three algorithms "Local communities" and "National NGOs" form a cluster – although with relatively more dissimilarities than other cluster consisting out of only two groups – that is *separated* from the other four groups before merging into one big cluster. This means that the cluster "Local communities and National NGOs" is relatively different from the other groups. The only difference is that within 'single linkage' there appears no cluster consisting out of *only* "Finance and Industry" and "Academia".

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