UN environment programme | CTCN UN Climate Technology Centre & Network

United Nations Climate Change
Technology Executive Committee

UN environment programme | copenhagen climate centre

ANNEXES

Climate Technology Progress Report 2023

CITATION

United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC);Climate Technology Centre and Network; and United Nations Framework Convention on Climate Change (UNFCCC) Technology Executive Committee (TEC) (2023). Climate Technology Progress Report 2023: Speed and Scale for Urban Systems Transformation., Copenhagen, Denmark.

Annex 1

APPENDIX A: TECHNOLOGIES BY GROUPINGS

Technology grouping	Discrete options for this feasibility assessment
Water management	Green infrastructures: green roofs and walls, green and bio swales, urban canopy. Blue infrastructures: Construction/restoration of wetlands, retention ponds, roof ponds. Others: permeable pavements, rainwater harvesting, decentralized water management, water reusing, early warning systems.
Public transport	Mass transit systems like busses, trams, and light rail trains (LRT)
Building cooling	Passive cooling strategies: overhangs, louvres, insulated walls and windows, diode roofs, textured walls, cool roofs (high albedo surfaces), modeling of building orientation and prevailing winds, new materials Enhanced ventilation: wind towers, wooden lattice openings, and solar chimneys. Green infrastructure: green roofs, green walls/green facades, roof ponds. HVAC: Evaporative cooling, and heat pumps.
Social housing	Housing resettlement (post-disaster resettlement and preventive resettlement of population in risk areas); informal settlements improvements; slum upgrading; community-led adaptation (with technical and economic government support); climate-resilient housing Regulation (urban and building codes; zones of environmental restriction to occupation) and monitoring and control systems.
Energy distribution and generation	Renewables on-site generation, microgrids, smart grids, and defensive islanding, energy reliability, infrastructure resilience

APPENDIX B: THE FEASIBILITY ASSESSMENT APPROACH

Feasibility for the global-level analysis conducted by the IPCC was defined along six dimensions: economic, technological, environmental, geophysical, sociocultural, and institutional. Indicators are then developed for each dimension. Indicators of feasibility within the dimensions are contextual and differ slightly between adaptation and mitigation options, and for adaptation options, between regions. The indicators were selected based on a review of scholarship and expert consultation and had underlying questions to guide the assessment of feasibility.

In the AR6 report, for adaptation, the assessment generally focused on whether or not a given indicator was a barrier, and whether or not there was a knowledge gaps. For mitigation, the assessment focused on whether indicators hindered or facilitated implementation. In defining some indicators as facilitators, the mitigation FA recognizes that some options are outperforming the options they aim to replace – e.g. solar PV being cheaper than fossil fuels. Similarly, mitigation options can also have co-benefits – e.g. electric vehicles and solar energy reduce local and regional air pollution – which also increases the potential for a mitigation option to be rapidly implemented and at a larger scale. For this assessment, the mitigation scores were recoded to the assessment approach used for adaptation.

A clear line of sight to the underlying evidence and literature was developed for each decision throughout the assessment. This involved carefully tracking the evidence for each option and mapping them onto specific indicators. As per IPCC guidance, confidence language was applied to each assessment based on the amount of, and the level of agreement on, the evidence.

Combining indicators for an overall feasibility score

Options can also be assigned an overall assessment. In a departure from AR6, both adaptation and mitigation options were assessed in the same method. Each feasibility dimension, overall feasibility was assessed as the arithmetic mean score of the relevant underlying indicators. Based on this, dimensions were classified as having insignificant barriers (2.5–3), mixed or moderate barriers (1.5–2.5) or significant barriers (below 1.5) to feasibility. Indicators assessed as not applicable (NA), limited evidence (LE), or no evidence (NE) were not included in this overall assessment. This mapping process is important for transparency purposes. Moreover, the same combining approach was used to assess the score of indicators grouped together for presentations purposes. This is shown in figure 1 below.

Figure 1. The multidimensional feasibility assessment of different mitigation and adaptation technologies

1. Define scope

Based on the scope of the study (global/national/local/sectoral) identify system transitions and underlying adaptation and mitigation technologies

2. Develop indicators

Across feasibility dimensions, develop indicators through literature review and expert elicitation

3. Create database

Conduct literature review for each adaptation technology at the indicator level

4. Conduct assessment

Assess each option at indicator-level giving scores for feasibility (high, medium and low), identifying where there is limited evidence (low evidence, no evidence), and where an indicator is not applicable

5. Check robustness

Cross-check each indicator-level score by 2-3 expert reviewers and adjust based on additional literature, regional diversity

6. Combine indicators

Combine indicator-level assessment (arithmetic mean of the relevant underlying indicators) to develop dimension-level score. The methods for combining the score is shown below.

7. Assess synergies and trade-offs

For adaptation options, assess positive or negative implications for mitigation

For mitigation options, assess positive or negative implications for adaptation

8. Report and visualise

Report dimension-level assessment through spider charts, traffic light tables etc. Differentiation of an option's feasibility diascussed in tables/text accompanying visuals

Calculating a score for each dimensions

High feasibility is weighed with a score of 3, medium feasibility with a score of 2 and low feasibility with a score of 1. This formula indicates, based on this weighing, how the composite feasibility of a dimension is obtained. The composite feasibility of an option, across dimensions, is calculated using the same weighing.

STEP 1

How many indicators in one dimension are effective (applicable)?

effective indicators = #indicators - #not applicable

STEP 2

How many indicators have sufficient litterature?

effective indicators - #NE & LE[1]

STEP 3

Average of the effective indicators with sufficient evidence[2]

$$\frac{(1*A + 2*B + 3*C)}{\text{\# effective indicators - \#NE \& LE}}$$

STEP 4

Assign category to dimension[3]

Legend of Feasibility Assessment Tables		Legend criteria for overall feasibility of each of the dimension-option combinations
Not applicable		All indicators are NA
Insufficient evidence		#NE & LE > 0.5 * #effective indicators
Low feasibility		AVG ≤ 1.5
Medium feasibilty		1.5 < AVG ≤ 2.5 #NE & LE ≤ 0.5 * #effective indicators
High feasibility		AVG > 2.5 #NE & LE ≤ 0.5 * #effective indicators

Source: modified from Singh et al. (2020)

[1] NA: Non-Applicable, NE: No Evidence, LE: Low Evidence
[2] Low = 1, medium = 2 and high =3 A, B and C represent three hypothetical indicators.
[3] This approach was followed for the adaptation assessment. A similar assessment was followed for mitigation on enablers and barriers, but the dimensions are continuous rather than discrete.

Ensuring robustness and transparency

All assessments drew on two rounds of internal review to ensure coherence, coverage and balance. Reviews included adding literature and improving the coverage of studies – e.g. to include evidence from Asian countries, peer-reviewed and grey literature – and removing any perceived biases. Each option's indicator-level assessment was validated by at least three authors. If indicator-level assessment differed, it was reconciled between the team of authors based on the literature each individually reviewed. As indicated above, for regional or contextual differences in option-level feasibility, text was used to explain the differentiating factors. Ideally, a systematic review would be conducted to comprehensively document relevant literature. However, when resources or time are limited, semi-systematic assessment approaches could be followed, such as standard practices of literature review – searching databases to achieve reference saturation – followed by careful and iterative reference checking, expert suggestions and internal peer review. The latter was employed for the AR6 reports due to time constraints resulting in assessing several thousand unique references for SR1.5, AR6 Working Group 2 and AR6 Working Group 3. When the process is downscaled at national or subnational level, where references are limited to allow an extensive literature review, the assessment can rely on expert consultations and grey literature.

APPENDIX C: FEASIBILITY ASSESSMENT FOR SELECTED TECHNOLOGIES

Dimensions	Adaptation Feasibility Analysis	WATER MANAGEMENT			
		Evidence		Robust	
		Agreement		Medium	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical feasibility	2.67	B	(Li et al. 2020; Chen et al. 2021; Kumar et al. 2021; Han et al. 2023)	(Ziervogel and Joubert 2014; Lamond, Rose and Booth 2015; Soz, Watson and Stanton-Geddes 2016; Chan et al. 2018; Nguyen et al. 2019)
	Hazard risk reduction potential		C	(Yau et al. 2017; Majidi et al. 2019; Ghodsi et al. 2020; Hermawan et al. 2020; Guptha et al. 2022; Zeng et al. 2023)	(Liu, Chen and Peng 2014; Angotti 2015; Bell and Taylor 2015; Biggs et al. 2015; Gwedla and Shackleton 2015; Lamond, Rose and Booth 2015; Lwasa et al. 2015; Voskamp and Van de Ven 2015; Chen and Chen 2016; Costa, Burlando and Priadi 2016; Mguni, Herslund and Jensen 2016; Yang et al. 2016; Sanesi et al. 2017; Xie et al. 2017; Gunasekara et al. 2018)
	Land use change enhancement potential		C	(Su et al. 2020)	(Lamond, Rose and Booth 2015; Leck et al. 2015; Padawangi and Douglass 2015; Rasul and Sharma 2016; Soz, Watson and Stanton-Geddes 2016)
Environmental-ecological	Ecological capacity	2.5	B	(Wang, Qin and Hu 2017; Biswal et al. 2022; Zhang and Li 2023)	(Chan et al. 2018; Dai, Wörner and van Rijswick 2018; Nguyen et al. 2019)
	Adaptive capacity/ resilience		C	(Fu et al. 2023; Y. Ma & Jiang 2023; T. T. Nguyen et al. 2019)	(Liu, Chen and Peng 2014; Angotti 2015; Bell and Taylor 2015; Biggs et al. 2015; Gwedla and Shackleton 2015; Lamond, Rose and Booth 2015; Lwasa et al. 2015; Voskamp and Van de Ven 2015; Chen and Chen 2016; Costa, Burlando and Priadi 2016; Mguni, Herslund and Jensen 2016; Yang et al. 2016; Sanesi et al. 2017; Xie et al. 2017; Gunasekara et al. 2018)
Technological	Technical resource availability	3	C	(Hoffmann et al. 2020; Su et al. 2020; Aivazidou et al. 2021; Alam et al. 2021; Parkinson 2021; Sharma, Seetharaman and Maddulety 2021)	(Liu, Chen and Peng 2014; Lamond, Rose and Booth 2015; Voskamp and Van de Ven 2015; Costa, Burlando and Priadi 2016; Mguni, Herslund and Jensen 2016; Soz, Watson and Stanton-Geddes 2016; Xie et al. 2017)
	Risks mitigation potential		C	(Hoffmann et al. 2020; Su et al. 2020; Aivazidou et al. 2021; Alam et al. 2021; Parkinson 2021; Sharma, Seetharaman and Maddulety 2021)	(Liu, Chen and Peng 2014; Lamond, Rose and Booth 2015; Voskamp and Van de Ven 2015; Costa, Burlando and Priadi 2016; Mguni, Herslund and Jensen 2016; Soz, Watson and Stanton-Geddes 2016; Xie et al. 2017; Gunasekara et al. 2018)

Economic	Socioeconomic vulnerability reduction potential	2.5	C	No change since AR6	(Liu and Jensen 2018; Jensen and Nair 2019; Oral et al. 2020)
	Employment and productivity enhancement potential		A	(Esmail and Suleiman 2020)	NE in AR6
	Microeconomic viability		C	No change since AR6	(Liu, Chen and Peng 2014; Lamond, Rose and Booth 2015; Voskamp and Van de Ven 2015; Xue et al. 2015; Costa, Burlando and Priadi 2016; Mguni, Herslund and Jensen 2016; Poff et al. 2016; Ossa-Moreno, Smith and Mijic 2017; Vincent et al. 2017; Xie et al. 2017)
	Macroeconomic viability		NE	NE	NE in AR6
Socio-cultural	Socio-cultural acceptability	2	B	No change since AR6	(Lamond, Rose and Booth 2015; Leck et al. 2015; Padawangi and Douglass 2015; Nur and Shrestha 2017; Xie et al. 2017)
	Social co-benefits (health, educa-tion)		C	(Chu 2018)	(Liu, Chen and Peng 2014; Lamond, Rose and Booth 2015; Leck et al. 2015; Padawangi and Douglass 2015; Voskamp and Van de Ven 2015; Costa, Bur-lando and Priadi 2016; Mguni, Herslund and Jensen 2016; Nur and Shrestha 2017; Xie et al. 2017; Gunasekara et al. 2018)
	Social and region-al inclusiveness		A	(Chu 2018; Rahmasary et al. 2019; Romano and Akhmouch 2019; Koop et al. 2022; Dieperink et al. 2023)	(Rasul and Sharma 2016)
	Gender equity		NA	NA	NA
	Intergenerational equity		NA	NA	NA
Institutional	Political accept-ability	1	A	No new evidence since SR 1.5	(Leck et al. 2015; Padawangi and Douglass 2015; Chen and Chen 2016; Mguni, Herslund and Jensen 2016)
	Legal and regula-tory acceptability		A	(Chu 2018; van den Brande-ler, Gupta and Hordijk 2019; Koop et al. 2022)	(Bettini, Brown and de Haan 2015; Deng and Zhao 2015; Hill Clarvis and Engle 2015; Leck et al. 2015; Lemos 2015; Margerum and Robinson 2015; Padawangi and Douglass 2015; Chen and Chen 2016)
	Institutional capacity and administrative feasibility		A	(Chu 2018; Romano and Akhmouch 2019; Koop et al. 2022; Grison et al. 2023)	(Ziervogel and Joubert 2014; Bettini, Brown and de Haan 2015; Deng and Zhao 2015; Hill Clarvis and Engle 2015; Lamond, Rose and Booth 2015; Lemos 2015; Margerum and Robinson 2015)
	Transparency and accountability potential		NE	NE	NE

Dimensions	Mitigation feasibility analysis	SUSTAINABLE AND RESILIENT WATER MANAGEMENT			
		Evidence		Robust	
		Agreement		Medium	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical potential	2.67	B	(Li et al. 2020; Chen et al. 2021; Kumar et al. 2021; Han et al. 2023)	(Elmqvist et al. 2019; Keeler et al. 2019; Quaranta, Dorati and Pistocchi 2021)
	Geophysical resources		C	No change since AR6	(Quaranta, Dorati and Pistocchi 2021)
	Land use		C	(Albert et al. 2019; Sarabi et al. 2019; Guidi Nissim and Labrecque 2021; Biswal et al. 2022)	(Nastran and Regina 2016; Fan et al. 2017; Raymond et al. 2017; Elmqvist et al. 2019; Slach et al. 2019; Quaranta, Dorati and Pistocchi 2021)
Environmetal-ecological	Air pollution	3	C	(Zhu, Ren and Liu 2019; Arbid, Richard and Sleiman 2021; Sahu, Basti and Sahu 2021; Viecco et al. 2021; Zheng et al. 2021)	(Kim and Coseo 2018; Santamouris et al. 2018; Elmqvist et al. 2019; Keeler et al. 2019; Song et al. 2019)
	Toxic waste, ecotoxicity, eutrophication		C	(Md. A. Ali & Pickering 2023; Hermawan et al. 2020; Shokri et al. 2021; H. Wang et al. 2017)	(Risch et al. 2018; Elmqvist et al. 2019; Keeler et al. 2019; Song et al. 2019)
	Water quantity and quality		C	(Nguyen et al. 2019; Neo et al. 2022; Zhou et al. 2023)	(Raymond et al. 2017; Albert et al. 2019; Elmqvist et al. 2019; Keeler et al. 2019)
	Biodiversity		C	(Wooster et al. 2022; Benedito Durà et al. 2023; Bruner et al. 2023; Liu et al. 2023)	(Schwarz et al. 2017; McPherson et al. 2018; Nero, Callo-Concha and Denich 2018; Elmqvist et al. 2019; Hale et al. 2019; Keeler et al. 2019)
Technological	Simplicity	3	C	(Hoffmann et al. 2020; Su et al. 2020; Aivazidou et al. 2021; Alam et al. 2021; Parkinson 2021; Sharma, Seetharaman and Maddulety 2021)	
	Technological scalability		C	(Hoffmann et al. 2020; Su et al. 2020; Aivazidou et al. 2021; Alam et al. 2021; Parkinson 2021; Sharma, Seetharaman and Maddulety 2021)	
	Maturity and technology readiness		C	(Hoffmann et al. 2020; Su et al. 2020; Aivazidou et al. 2021; Alam et al. 2021; Parkinson 2021; Sharma, Seetharaman and Maddulety 2021)	
Economic	Costs in 2030 and long term	2.5	C	No new evidence since SR 1.5	(Elmqvist et al. 2019)
	Employment effects and economic growth		B	No new evidence since SR 1.5	(Thomson and Newman 2016; Raymond et al. 2017; Kareem et al. 2020)
Socio-cultural	Public acceptance	2	A	(Garnier and Holman 2019; Fernandez et al. 2022; Kanchanapiya and Tantisattayakul 2022; Perrone et al. 2023)	
	Effects on health and well-being		B	(Daniel, Pande and Rietveld 2021)	
	Distributional effect		C	(Daniel, Pande and Rietveld 2021)	
Institutional	Political acceptance	3	NE		
	Institutional capacity and governance, cross-sectoral coordination		C	(Loch, Adamson and Dumbrell 2020)	
	Legal and administrative feasibility		C		

Dimensions	Mitigation feasibility analysis	PUBLIC TRANSPORT			
		Evidence		Robust	
		Agreement		Medium	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical potential	3	C	(Rith, Fillone and Biona 2019; Nieuwenhuijsen 2020b; Ceder 2021; Gutiérrez, Miravet and Domènech 2021)	(Newman et al. 2017; Schiller & Kenworthy 2017)
	Geophysical resources		C	No new evidence	(Lin and Du 2017; Schiller and Kenworthy 2017)
	Land use		C	(Nigro, Bertolini and Moccia 2019; Rith, Fillone and Biona 2019; Nieuwenhuijsen 2020b; Anastasiadou and Gavanas 2023)	(Ahmad et al. 2016; Schiller and Kenworthy 2017)
Environmental-ecological	Air pollution	3	C	(Napitupulu, Ismiyati and Handajani 2018; Ambarwati and Indriastuti 2019; C. Sun et al. 2019; Quarmby, Santos and Mathias 2019; Nieuwenhuijsen 2020b; Rivers, Saberian and Schaufele 2020; Triguero-Mas et al. 2020; González, Perdiguero and Sanz 2021; Ma, Graham and Stettler 2021; Li, Yuan and Li 2022; Wong et al. 2022; Zhai et al. 2022)	(Schiller and Kenworthy 2017; Glazebrook and Newman 2018; Yangka and Newman 2018; Zhang, Matsushima and Kobayashi 2018)
	Toxic waste, ecotoxicity, eutrophication		LE		(Newman, Beatley and Boyer 2017)
	Water quantity and quality		LE		(Newman, Beatley and Boyer 2017)
	Biodiversity		C	(Alshammari 2022)	(Newman, Beatley and Boyer 2017; Schiller and Kenworthy 2017)
Technological	Simplicity	2.33	B	(Hrelja, Khan and Pettersson 2020)	(Newman, Beatley and Boyer 2017; Schiller and Kenworthy 2017)
	Technological scalability		B*	(Paiva et al. 2021)	(Newman, Beatley and Boyer 2017; Schiller and Kenworthy 2017; Yangka and Newman 2018)
	Maturity and technology readiness		C	(Tsakalidis, Gkoumas and Pekár 2020; Wołek et al. 2021)	(Newman, Beatley and Boyer 2017; Schiller and Kenworthy 2017)
Economic	Costs in 2030 and long term	3	C	(Pérez-Prada et al. 2019; Godínez-Zamora et al. 2020; Sofia et al. 2020; Goel and Chowdhary 2022; Jarecki 2023)	(Nahlik and Chester 2014; Bouf and Faivre d'Arcier 2015; Lin and Du 2017; Schiller and Kenworthy 2017; Glazebrook and Newman 2018)
	Employment effects and economic growth		B*	(Chen and Karimi 2019; Hanyurwumutima and Gumede 2021)	(Hazledine, Donovan and Mak 2017; Schiller and Kenworthy 2017; Gao and Newman 2018)
Socio-cultural	Public acceptance	2.67	B	(Fointiat and Feliot-Rippeault 2019; Wang, Curtis and Scheurer 2020; Guno, Collera and Agaton 2021)	(STEG 2003; Wijaya, Imran and McNeill 2017)
	Effects on health and well-being		C*	(Rojas-Rueda et al. 2012 2013; Rambaldini-Gooding et al. 2021)	(STEG 2003; Nahlik and Chester 2014; Lin and Du 2017; Yangka and Newman 2018)
	Distributional effect		C	(Fearnley and Aarhaug 2019; Pereira et al. 2019; Saif, Zefreh and Torok 2019)	(Schiller and Kenworthy 2017; Linovski, Baker and Manaugh 2018; Yangka and Newman 2018)
Institutional	Political acceptance	3	B*	(Thaller et al. 2021; Hochachka and Mérida 2023)	(Schiller and Kenworthy 2017; Wijaya, Imran and McNeill 2017; Gao and Newman 2018; Glazebrook and Newman 2018; Mohamed, Ferguson and Kanaroglou 2018; Sharma 2018; Yangka and Newman 2018)
	Institutional capacity and governance, cross-sectoral coordination		C	(Hirschhorn et al. 2019; Sørensen, Hansson and Rye 2023)	(Newman, Beatley and Boyer 2017; Schiller and Kenworthy 2017; Sharma 2018)
	Legal and administrative feasibility		B*	No new evidence	(Schiller and Kenworthy 2017; Yangka and Newman 2018)

Dimensions	Adaptation Feasibility Analysis	COOLING			
		Evidence		Robust	
		Agreement		Medium	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical feasibility	2	B		(Voskamp and Van de Ven 2015)
	Hazard risk reduction potential		B		(Nowak, Crane and Stevens 2006; Steenhof and Sparling 2011; Tallis et al. 2011; Elmqvist et al. 2013 2015; Soderlund and Newman 2015; Bendito and Barrios 2016; Brown and McGranahan 2016; Camps-Calvet et al. 2016; McPhearson et al. 2016; Panagopoulos, González Duque and Bostenaru Dan 2016; Stevenson et al. 2016; Ziervogel et al. 2016; Collas et al. 2017; Li et al. 2017; Reckien et al. 2017; Zinia and McShane 2018)
	Land use change enhancement potential		B		(Tallis et al. 2011; Elmqvist et al. 2013; Bendito and Barrios 2016; Panagopoulos, González Duque and Bostenaru Dan 2016; Collas et al. 2017; Reckien et al. 2017)
Environmental-ecological	Ecological capacity	2	B	(Arbid, Richard and Sleiman 2021; Viecco et al. 2021; Aleksejeva, Voulgaris and Gasparatos 2022; Heidari and Eskandari 2022; Nguyen et al. 2022; Susca et al. 2022; Tao et al. 2022; Xiao and Du 2022; Cao et al. 2023; Weisser et al. 2023)	(Filazzola, Shrestha and MacIvor 2019)
	Adaptive capacity/ resilience		B		(Beatley 2011; Steenhof and Sparling 2011; Elmqvist et al. 2013 2015; Voskamp and Van de Ven 2015; Beaudoin and Gosselin 2016; Bendito and Barrios 2016; Brown and McGranahan 2016; Camps-Calvet et al. 2016; McPhearson et al. 2016; Panagopoulos, González Duque and Bostenaru Dan 2016; Collas et al. 2017; Li et al. 2017; Zinia and McShane 2018)
Technological	Technical resource availability	2	B	(Khosla et al. 2022)	(Steenhof and Sparling 2011; Bendito and Barrios 2016; Chandel, Sharma and Marwaha 2016; Ruparathna, Hewage and Sadiq 2016; Tait and Euston-Brown 2017; Wells, Rismanchi and Aye 2018)
	Risks mitigation potential		B		(Ruparathna, Hewage and Sadiq 2016; Anguelovski, Irazábal-Zurita and Connolly 2019)
Economic	Socioeconomic vulnerability reduction potential	2.5	C		(Anguelovski et al. 2019; Buijs et al. 2019; Escobedo et al. 2019; Filazzola et al. 2019; Hewitt et al. 2020; Langemeyer & Connolly 2020; Nieuwenhuijsen 2020a; Venter, Krog, et al. 2020; Venter, Shackleton, et al. 2020)
	Employment and productivity enhancement potential		C	(Duran and Lomas 2021; Kükrer and Eskin 2021; Tang et al. 2021)	(Steenhof and Sparling 2011; Bendito and Barrios 2016; Ruparathna, Hewage and Sadiq 2016; Wells, Rismanchi and Aye 2018)
	Microeconomic viability		B		(Steenhof and Sparling 2011; Elmqvist et al. 2015; Soderlund and Newman 2015; Bendito and Barrios 2016; McPhearson et al. 2016; Ruparathna, Hewage and Sadiq 2016; Wells, Rismanchi and Aye 2018; Zinia and McShane 2018)
	Macroeconomic viability		B		(Steenhof and Sparling 2011; Chandel, Sharma and Marwaha 2016; Shapiro 2016; Hess and Kelman 2017; Wells, Rismanchi and Aye 2018)

Socio-cultural	Socio-cultural acceptability	2.5	C		(Beatley 2011; Elmqvist et al. 2015; Beaudoin and Gosselin 2016; Bendito and Barrios 2016; Brown and McGranahan 2016; Camps-Calvet et al. 2016; Eisenberg 2016; McPhearson et al. 2016; Ziervogel, Cowen and Ziniades 2016; Collas et al. 2017; Li et al. 2017; Tait and Euston-Brown 2017; Zinia and McShane 2018)
	Social co-benefits (health, education)		C	(Khosla et al. 2022)	(Escobedo et al. 2019; Filazzola et al. 2019; Hewitt et al. 2020; Nieuwenhuijsen 2020a; Venter, Krog, et al. 2020)
	Social and regional inclusiveness		B		(Anguelovski et al. 2019; Buijs et al. 2019; Hewitt et al. 2020; Langemeyer & Connolly 2020; Nieuwenhuijsen 2020a; Parnell 2015; Reckien et al. 2017; Shapiro 2016; Venter, Krog, et al. 2020; Venter, Shackleton, et al. 2020)
	Gender equity		LE		(Anguelovski et al. 2019; Buijs et al. 2019; Hewitt et al. 2020; Langemeyer & Connolly 2020; Nieuwenhuijsen 2020a; Venter, Krog, et al. 2020; Venter, Shackleton, et al. 2020)
	Intergenerational equity		B		(Elmqvist et al. 2013 2015; Voskamp and Van de Ven 2015)
Institutional	Political acceptability	2	B		LE
	Legal and regulatory acceptability		B		(Brown and McGranahan 2016; Ziervogel, Cowen and Ziniades 2016; Collas et al. 2017; Li et al. 2017)
	Institutional capacity and administrative feasibility		B		(Dorst et al. 2019; Zwierzchowska et al. 2019)
	Transparency and accountability potential		B		(Steenhof and Sparling 2011; Chandel, Sharma and Marwaha 2016; Shapiro 2016)

Dimensions	Mitigation feasibility analysis	COOLING			
		Evidence		Robust	
		Agreement		Medium	
		Dim. Avg	Indicator Score Grey I Overall	References (update)	References (AR6/SR1.5)
Geophysical	Physical potential	N/A I 2	N/A I B	(Erba, Sangalli and Pagliano 2019; Guerrero Delgado, Sánchez Ramos and Álvarez Domínguez 2020; Aviv et al. 2021; Li and Chen 2021; Sheppard et al. 2022; Visakha and Srinivas 2023)	(Tatsidjodoung, Le Pierrès and Luo 2013; Pérez et al. 2014; Elmqvist et al. 2015; Kalnæs and Jelle 2015; Charoenkit and Yiemwattana 2016; Nastran and Regina 2016; Navarro et al. 2016; Aditya et al. 2017; Fan et al. 2017; Olsthoorn et al. 2017; Raymond et al. 2017; Cabeza, de Gracia and Pisello 2018; Cascone et al. 2018; Shafigh, Asadi and Mahyuddin 2018; Sun et al. 2018; Bamisile et al. 2019; Belussi et al. 2019; Bhamare, Rathod and Banerjee 2019; Gong et al. 2019; Irshad et al. 2019; Keeler et al. 2019; Lidelöw et al. 2019; Slach et al. 2019; Cabeza and Chàfer 2020; Cabeza, Chàfer and Mata 2020; Dilshad, Kalair and Khan 2020; Dong et al. 2020; Omrany et al. 2020; Peng et al. 2020; Quaranta, Dorati and Pistocchi 2021)
	Geophysical resources		N/A I B		
	Land use		N/A I B		
Environmental-ecological	Air pollution	2.75 I 3	B I C		(McPhearson et al. no date; Hui and Chan 2011; Elmqvist et al. 2015; Holland et al. 2015; Fricko et al. 2016; Levy et al. 2016; Balaban and de Oliveira 2017; Ferreira, Almeida and Rodrigues 2017; Galvin and Sunikka-Blank 2017; Raymond et al. 2017; Schwarz et al. 2017; Jandaghian and Akbari 2018; Joimel et al. 2018; Kim and Coseo 2018; MacNaughton et al. 2018; Mayrand and Clergeau 2018; McCollum et al. 2018; Nero, Callo-Concha and Denich 2018; Santamouris et al. 2018; Scholz, Hof and Schmitt 2018; Albert et al. 2019; Hale et al. 2019; Keeler et al. 2019; Song et al. 2019)
	Toxic waste, ecotoxicity, eutrophication		C I C		
	Water quantity and quality		C I C		
	Biodiversity		C I C		
Technological	Simplicity	2 I 2	B IB	(Guerrero Delgado, Sánchez Ramos and Álvarez Domín-guez 2020)	(Choe, 1973; Soares et al. 2013; Tatsidjodoung, Le Pierrès and Luo 2013; Noro, Lazzarin and Busato 2014; Pérez et al. 2014; Chen 2015; Elmqvist et al. 2015; Lee, Lee and Lee 2015; Rafique et al. 2015; Raji, Tenpierik and Van Den Dobbelsteen 2015; Harby et al. 2016; Khadiran et al. 2016; Mavrigiannaki and Ampatzi 2016; Ruckelshaus et al. 2016; Silva, Vicente and Rodrigues 2016; Aditya et al. 2017; Bomberg, Furtak and Yarbrough 2017; Cleveland et al. 2017; Ferrari et al. 2017; Lwasa 2017; Raymond et al. 2017; Riley 2017; Gargiulo et al. 2018; Grubler et al. 2018; Kanniah and Siong 2018; Reddy, Mudgal and Mallick 2018; Sasaki et al. 2018; Shafigh, Asadi and Mahyuddin 2018; Singaravel, Suykens and Geyer 2018; Sun, Wilson and Wu 2018; Wang, Chen and Shi 2018; Albert et al. 2019; Belussi et al. 2019; De la Sota et al. 2019; De Masi et al. 2019; Dorst et al. 2019; Drissi et al. 2019; Irshad et al. 2019; Keeler et al. 2019; Li et al. 2019; Si et al. 2019; Soltani et al. 2019; Deng et al. 2020; Ge et al. 2020; Grafakos et al. 2020; Hadjadj et al. 2020; Husin, Rahmat and Wahab 2020; Omrany et al. 2020; Pahinkar, Boman and Garimella 2020; Peng et al. 2020; Roca-Puigròs et al. 2020; Sha and Qi 2020; Talkar, Choudhari and Rayar 2020; Teja S and Yemula 2020; Vilar, Xydis and Nanaki 2020; Dalla Valle 2021; Du 2021; Feng et al. 2021; Getuli, Capone and Bruttini 2021; Gholami, Røstvik and Steemers 2021; Hosseini et al. 2021; Kim and Suh 2021; Kunwar, Cetin and Passe 2021; Lo Basso et al. 2021; Pauliuk et al. 2021; Rice 2021; Čurpek and Čekon 2022)
	Technological scalability		B I B	No new evidence	
	Maturity and technology eadiness		B I B	(Bhamare, Rathod and Banerjee 2019; Guerrero Delgado, Sánchez Ramos and Álvarez Domínguez 2020; Haggag 2021)	

Economic	Costs in 2030 and long term	2 | 2	B | B	(Rabczak and Nowak 2022)	(Afshari, Nikolopoulou and Martin 2014; Mirasgedis et al. 2014; Elmqvist et al. 2015; Akander, Cehlin and Moshfegh 2016; Holopainen et al. 2016; Thomson and Newman 2016; Ürge-Vorsatz et al. 2016 2020; Ismailos and Touchie 2017; Mofidi and Akbari 2017; Paduos and Corrado 2017; Raymond et al. 2017; Semprini, Gulli and Ferrante 2017; Streicher et al. 2017; Subramanyam, Ahiduzzaman and Kumar 2017; Subramanyam et al. 2017; Bleyl et al. 2018; D'Agostino and Parker 2018; D'Oca et al. 2018; McCollum et al. 2018; Novikova, Csoknyai and Szalay 2018; Saheb et al. 2018; Alawneh et al. 2019; BAL KOÇYİĞİT et al. 2019; Erhorn-Kluttig et al. 2019; Mata et al. 2019; Morck et al. 2019; Nocera et al. 2019; Onyenokporo and Ochedi 2019; Österbring et al. 2019; Reiter et al. 2019; Serrenho et al. 2019; Zinzi and Mattoni 2019; Zuhaib and Goggins 2019; Alajmi et al. 2020; González-Hidalgo and Zografos 2020; Grande-Acosta and Islas-Samperio 2020; Kareem et al. 2020; William et al. 2020; Calise et al. 2021; Deetjen, Walsh and Vaishnav 2021; Seeley and Dhakal 2021; Stancioff et al. 2021)
	Employment effects and economic growth		LE | B		
Socio-cultural	Public acceptance	2.5 | 2	B | B	No new evidence	(Allcott and Greenstone 2012; Christidou, Tsagarakis and Athanasiou 2014; Curl et al. 2014; Qiu, Colson and Grebitus 2014; García-López and Heard 2015; Hamilton et al. 2015; Lwasa 2015; Payne, Weatherall and Downy 2015; Smith et al. 2015; Thomson and Thomas 2015; Willand, Ridley and Maller 2015; Friege 2016; Levy et al. 2016; Markovska et al. 2016; Miezis et al. 2016; Mortensen, Heiselberg and Knudstrup 2016; Tam, Wang and Le 2016; Ürge-Vorsatz et al. 2016 2018; Balaban and de Oliveira 2017; Clancy, Curtis and O'Gallachóir 2017; Curtis, Walton and Dodd 2017; Ferreira, Almeida and Rodrigues 2017; Heiskanen and Matschoss 2017; Huang et al. 2017; Lilley, Davidson and Alwan 2017; Ozarisoy and Altan 2017; Poortinga et al. 2017; Raymond et al. 2017; Silva et al. 2017; Swan et al. 2017; Thomson, Bouzarovski and Snell 2017; van den Bosch and Ode Sang 2017; Zuhaib et al. 2017; Cedeño-Laurent et al. 2018; Fisk 2018; Howarth and Roberts 2018; Ketchman et al. 2018; Militello-Hourigan and Miller 2018; Morris, Vine and Buys 2018; Privitera and La Rosa 2018; Saheb et al. 2018; Santamouris et al. 2018; Si and Marjanovic-Halburd 2018; Tonn, Rose and Hawkins 2018; Tsoka et al. 2018; Tumbaz and Moğulkoç 2018; Underhill et al. 2018; Wierzbicka et al. 2018; Abreu, Wingartz and Hardy 2019; Alawneh et al. 2019; Andersson et al. 2019; Azizi, Nair and Olofsson 2019; Boermans and Galema 2019; Bright, Weatherall and Willis 2019; Ellsworth-Krebs 2019; Fournier et al. 2019; Keeler et al. 2019; Khumalo and Sibanda 2019; Kim, Sunitiyoso and Medal 2019; Lorek and Spangenberg 2019; Mastrucci et al. 2019; Ortiz, Casquero-Modrego and Salom 2019; Song et al. 2019; Trencher and van der Heijden 2019; Bevan, Lu and Sexton 2020; Cunha et al. 2020; Grafakos et al. 2020; Jamei et al. 2020; Karlsson, Alfredsson and Westling 2020; Reindl and Palm 2020; Spandagos et al. 2020; Cohen 2021; Mata et al. 2021; Quaranta, Dorati and Pistocchi 2021)
	Effects on health and well-being		C | B	No new evidence	
	Distributional effect		LE | B		
Institutional	Political acceptance	2 | 2	B | B	(Hess and Renner 2019; Dupont 2021)	(Pérez-Lombard et al. 2011; Pisello and Asdrubali 2014; Chen, Yang and Lu 2015; Elmqvist et al. 2015; He et al. 2015; Chandel, Sharma and Marwaha 2016; Khosla 2016; Sun et al. 2016; Fan et al. 2017; Khosla, Sagar and Mathur 2017; Linnenluecke et al. 2017; Pérez-Bella et al. 2017; Raymond et al. 2017; Yan et al. 2017; Grandin et al. 2018; Jahanfar, Sleep and Drake 2018; Albert et al. 2019; Childers et al. 2019; Dorst et al. 2019; Fournier et al. 2019 2020; Keeler et al. 2019; Kelpsaite, Schloemann and Kearney 2019; Papadopoulos et al. 2019; Pellegrini-Masini 2019; Vadovics and Živčič 2019; Enker and Morrison 2020; Grafakos et al. 2020; Kontokosta, Spiegel-Feld and Papadopoulos 2020; Kwag et al. 2020; Liu, Tan and Li 2020; Schwarz, Nakhle and Knoeri 2020)
	Institutional capacity and governance, cross-sectoral coordination		B | B	(H. Sun et al. 2019; Ren, Hao and Wu 2022)	
	Legal and administrative feasibility		B | B	No new evidence	

Dimensions	Adaptation Feasibility Analysis	SOCIAL HOUSING			
		Evidence		Not assessed	
		Agreement		Not assessed	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical feasibility	1.67	A	(Balachandran, Olshansky and Johnson 2022; Carrasco and Egbelakin 2022; Hossain et al. 2022)	Not assessed
	Hazard risk reduction potential		A	(Jain and Bazaz 2020; Carrasco and Egbelakin 2022; Hossain et al. 2022; Tiwari and Shukla 2022)	Not assessed
	Land use change enhancement potential		C	(Carrasco and Egbelakin 2022; Hossain et al. 2022)	Not assessed
Environmental-ecological	Ecological capacity	LE	LE	(Dorevitch et al. 2006; Zhang and Jim 2014; Belcher and Chisholm 2018; van Deventer et al. 2022)	Not assessed
	Adaptive capacity/ resilience		NE		Not assessed
Technological	Technical resource availability	1	A	(Sultana and Tan 2021; Carrasco and Egbelakin 2022; Parvin, Mostafa and Syangadan 2023; Waage Skjeflo et al. 2023)	Not assessed
	Risks mitigation potential		A	(Jain and Bazaz 2020; Parvin, Mostafa and Syangadan 2023)	Not assessed
Economic	Socioeconomic vulnerability reduction potential	1	A	(Jain and Bazaz 2020; See and Wilmsen 2020; Carrasco and Egbelakin 2022)	Not assessed
	Employment and productivity enhancement potential		A	(Jain and Bazaz 2020)	Not assessed
	Microeconomic viability		A	(Satterthwaite et al. 2020; Sultana and Tan 2021; Waage Skjeflo et al. 2023)	Not assessed
	Macroeconomic viability		NE		Not assessed
Socio-cultural	Socio-cultural acceptability	1.25	B {a &c}	(Chu, Anguelovski and Roberts 2017; See and Wilmsen 2020; Singh et al. 2021; Carrasco and Egbelakin 2022; Waage Skjeflo et al. 2023)	Not assessed
	Social co-benefits (health, education)		A	(Deshpande, Michael and Bhaskara 2019; Jain and Bazaz 2020; Singh et al. 2021; Carrasco and Egbelakin 2022; Parvin, Mostafa and Syangadan 2023; Wolff, Rauf and Hamel 2023)	Not assessed
	Social and regional inclusiveness		A	(Yu et al. 2016; Deshpande, Michael and Bhaskara 2019; See and Wilmsen 2020; Singh et al. 2021; Sultana and Tan 2021; Parvin, Mostafa and Syangadan 2023; Wolff, Rauf and Hamel 2023)	Not assessed
	Gender equity		A	(Jain and Bazaz 2020; See and Wilmsen 2020; Singh et al. 2021)	Not assessed
	Intergenerational equity		NE		Not assessed
Institutional		1.5	B {a &c}	(Du, Greiving and Yap 2022)	Not assessed
	Legal and regulatory acceptability		B	(Du, Greiving and Yap 2022; Parvin, Mostafa and Syangadan 2023)	Not assessed
	Institutional capacity and administrative feasibility		A	(Satterthwaite et al. 2020; Singh et al. 2021; Carrasco and Egbelakin 2022; Du, Greiving and Yap 2022; Parvin, Mostafa and Syangadan 2023; Waage Skjeflo et al. 2023)	Not assessed
	Transparency and accountability potential		A	(See and Wilmsen 2020)	Not assessed

Dimensions	Mitigation feasibility analysis	SOCIAL HOUSING			
		Evidence		Not assessed	
		Agreement		Not assessed	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical potential	2.5	B		Not assessed
	Geophysical resources		N/A	N/A	Not assessed
	Land use		C	(Häkkinen et al. 2013; Qian et al. 2016)	Not assessed
Environmental-ecological	Air pollution	2	B	(Tuominen, Forsström and Honkatukia 2013; Fawcett and Killip 2019; Reuter et al. 2020)	Not assessed
	Toxic waste, ecotoxicity, eutrophication		N/A	N/A	Not assessed
	Water quantity and quality		B		Not assessed
	Biodiversity		B	(Poptani and Bandyopadhyay 2014; Oquendo-Di Cosola et al. 2020)	Not assessed
Technological	Simplicity	2	B	(Danassis et al. 2017; Ahmad, Naeem and Ahmad 2019)	Not assessed
	Technological scalability		B	(Bukovszki et al. 2019; Morales-Inzunza et al. 2023)	Not assessed
	Maturity and technology readiness		B (LE)	(Wang, Shi and Lu 2021)	Not assessed
Economic	Costs in 2030 and long term	2.5	B	(Baglivo et al. 2015; Kuusk and Kalamees 2016; Simson et al. 2019; Ansah, Chen and Yang 2022)	Not assessed
	Employment effects and economic growth		C	(Meijer and Visscher 2014; Mikulić, Bakarić and Slijepčević 2016; Mikulić, Rašić Bakarić and Slijepčević 2016; Fawcett and Killip 2019; Mikulić, Slijepčević and Buturac 2020; Reuter et al. 2020; Mikulić, Lovrinčević and Keček 2021)	Not assessed
Socio-cultural	Public acceptance	2.33	C	(Zhao et al. 2015; Hamza 2016; Kosorić et al. 2019)	Not assessed
	Effects on health and well-being		C	(Dreyer et al. 2018; Fawcett and Killip 2019; Reuter et al. 2020; Tao, Zhu and Passe 2020)	Not assessed
	Distributional effect		A	(Bouzarovski, Frankowski and Tirado Herrero 2018; Femenias, Punzi and Granath 2022; Gou, Zhai and Wang 2023)	Not assessed
Institutional	Political acceptance	1.67	B	(Hess and Renner 2019; Karapin and Vogel 2023)	Not assessed
	Institutional capacity and governance, cross-sectoral coordination		A	(Foo 2015)	Not assessed
	Legal and administrative feasibility		B	(Vine, Williams and Price 2016; Evans, Roshchanka and Graham 2017)	Not assessed

Dimensions	Adaptation Feasibility Analysis	ENERGY DISTRIBUTION AND GENERATION			
		Evidence		Medium	
		Agreement		Medium	
		Dim. Avg	Indicator Score	References (up-date)	References (AR6/SR1.5)
Geophysical	Physical feasibility	2.67	C	(Urbano et al. 2022)	(Calvert and Mabee 2015; Foxon et al. 2015; Capellán-Pérez, de Castro and Arto 2017; Green and Newman 2017; Poggi, Firmino and Amado 2018; Wiktorowicz et al. 2018)
	Hazard risk reduction potential		C	(Usman and Rad-ulescu 2022; Li et al. 2023)	(Marto, Papageorgiou and Klyuev 2018; Bajwa et al. 2019; Mishra et al. 2020)
	Land use change enhancement potential		B	(Song et al. 2022; Zhang et al. 2022; Abubakar and Alshammari 2023)	NA
Environmental-ecological	Ecological capacity	2	B	(Ali et al. 2022; Farzaneh et al. 2022; Shehadeh, Siam and Abdo 2022; Tan, Jia and Ramakrishna 2022; Cojoianu et al. 2023; Hamed Banirazi Motlagh, Hosseini and Pons-Valladares 2023)	(Clerici, Cova and Callegari 2015; Cameron et al. 2016; Balaban and de Oliveira 2017; Newman, Beatley and Boyer 2017; Rao and Pachauri 2017; Goldemberg et al. 2018; Rosenthal et al. 2018; Steenland et al. 2018; Osabuohien et al. 2021)
	Adaptive capacity/ resilience		B	(Axon and Darton 2021; Bellezoni et al. 2021; Dorahaki et al. 2021)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; Espinoza et al. 2016; Dawson et al. 2018; Hallegatte, Rentschler and Rozenberg 2019; Mishra et al. 2020; Bennett et al. 2021; Schweikert and Deinert 2021)
Technological	Technical resource avail-ability	3	C	(Alsagr & van Hemmen 2021; Shabalov et al. 2021; Sovacool et al. 2022)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Panteli et al. 2016 2017; Panteli and Mancar-ella 2017; Dawson et al. 2018; O'neill-Carrillo and A.rivera-Quiñones 2018; Arowolo et al. 2019; Bajwa et al. 2019; Bustamante et al. 2019; Hallegatte, Rentschler and Rozenberg 2019; Kim et al. 2019; O'Neill-Carrillo et al. 2019; Chester, Underwood and Samaras 2020; Raoufi, Vahidinasab and Mehran 2020; Ratnam et al. 2020; Bennett et al. 2021; Jasiūnas et al. 2021; Schweikert and Deinert 2021; Helmrich and Chester 2022)
	Risks mitiga-tion potential		LE		
Economic	Socioeconomic vulnerability reduction potential	2.5	C		(Verschuuren 2013; de Almeida and Mostafavi 2016; Espinoza et al. 2016; Panteli and Mancarella 2017; Panteli et al. 2017; Dawson et al. 2018; Marto, Papageorgiou and Klyuev 2018; Meltzer 2018; O'neill-Carrillo and A.rivera-Quiñones 2018; Arowolo et al. 2019; Hal-legatte, Rentschler and Rozenberg 2019; Kim et al. 2019; Kwasinski et al. 2019; Ratnam et al. 2020; Balezentis et al. 2021; Bennett et al. 2021; Jasiūnas et al. 2021; Schweikert and Deinert 2021)
	Employment and productiv-ity enhance-ment potential		C		(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Panteli et al. 2017; Dawson et al. 2018; Arowolo et al. 2019; Hallegatte, Rentschler and Rozenberg 2019; Kim et al. 2019; Chester, Underwood and Samaras 2020; Gebreslassie 2020; Balezentis et al. 2021; Jasiūnas et al. 2021)
	Microeconomic viability		C		(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Espinoza et al. 2016; Panteli et al. 2017; Dawson et al. 2018; Helgeson and O'Rear 2018; Marto, Papageor-giou and Klyuev 2018; Meltzer 2018; Mola, Feofilovs and Romagnoli 2018; O'neill-Carrillo and A.rivera-Quiñones 2018; Arowolo et al. 2019; Kim et al. 2019; Kwasinski et al. 2019; Chester, Underwood and Samaras 2020; Mishra et al. 2020; Nik and Perera 2020; Ratnam et al. 2020; Balezentis et al. 2021; Bennett et al. 2021; Jasiūnas et al. 2021; Stephenson, Sovacool and Inderberg 2021)
	Macroeconom-ic viability		A		(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Espinoza et al. 2016; Panteli and Mancarella 2017; Panteli et al. 2017; Dawson et al. 2018; Marto, Papageorgiou and Klyuev 2018; Meltzer 2018; Arowolo et al. 2019; Bajwa et al. 2019; Hallegatte, Rentschler and Rozenberg 2019; Kim et al. 2019; Kwasinski et al. 2019; Chester, Underwood and Samaras 2020; Rat-nam et al. 2020; Bennett et al. 2021; Jasiūnas et al. 2021; Stephen-son, Sovacool and Inderberg 2021)

Socio-cultural	Socio-cultural acceptability	2.75	B	(Bögel et al. 2021; Haque, Lemanski and de Groot 2021; Cruz May et al. 2022; Schönauer and Glanz 2022; Vega-Araújo and Heffron 2022; Wiertz, Kuhn and Mattissek 2023)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; Espinoza et al. 2016; Aklin, Harish and Urpelainen 2018; Dawson et al. 2018; Arowolo et al. 2019; Hallegatte, Rentschler and Rozenberg 2019; Kim et al. 2019; Chester, Underwood and Samaras 2020; Johnson et al. 2020; Perera et al. 2020; Balezentis et al. 2021; Jasiūnas et al. 2021; Oviedo-Toral, François and Poganietz 2021; Vuichard, Stauch and Wüstenhagen 2021)
	Social co-benefits (health, education)		C	(Banerjee, Mishra and Maruta 2021; Lema et al. 2021; Sharifi et al. 2021; Sadiq et al. 2022; Zakari et al. 2022)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Espinoza et al. 2016; Aklin, Harish and Urpelainen 2018; Dawson et al. 2018; Helgeson and O'Rear 2018; Arowolo et al. 2019; Kim et al. 2019; Chester, Underwood and Samaras 2020; Johnson et al. 2020; Nik and Perera 2020; Balezentis et al. 2021; Jasiūnas et al. 2021; Oviedo-Toral, François and Poganietz 2021; Vuichard, Stauch and Wüstenhagen 2021)
	Social and regional inclusiveness		C	(Kallis et al. 2021; Komendantova 2021; Bauwens et al. 2022; Wahlund and Palm 2022)	(Verschuuren 2013; Aklin, Harish and Urpelainen 2018; Dawson et al. 2018; Hallegatte, Rentschler and Rozenberg 2019; Johnson et al. 2020; Nik and Perera 2020; Balezentis et al. 2021; Jasiūnas et al. 2021; Oviedo-Toral, François and Poganietz 2021; Vuichard, Stauch and Wüstenhagen 2021)
	Gender equity		NE		(Aklin, Harish and Urpelainen 2018; Hallegatte, Rentschler and Rozenberg 2019; Johnson et al. 2020; Jasiūnas et al. 2021; Oviedo-Toral, François and Poganietz 2021)
	Intergenerational equity		C	(Kouloumpis & Yan 2021; Pereira et al. 2022)	(Aklin, Harish and Urpelainen 2018; Johnson et al. 2020; Jasiūnas et al. 2021; Oviedo-Toral, François and Poganietz 2021)
Institutional	Political acceptability	2.33	C	(Antwi and Ley 2021; Salak et al. 2021; Dessi et al. 2022; Gordon, Balta-Ozkan and Nabavi 2022; Szabo 2022; Knauf and le Maitre 2023)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Panteli et al. 2017; Dawson et al. 2018; Marto, Papageorgiou and Klyuev 2018; Mola, Feofilovs and Romagnoli 2018; Arowolo et al. 2019; Hallegatte, Rentschler and Rozenberg 2019; Farahmand et al. 2020; Nik and Perera 2020; Osabuohien et al. 2021; Oviedo-Toral, François and Poganietz 2021; Stephenson, Sovacool and Inderberg 2021)
	Legal and regulatory acceptability		B	(Camarasa, Kalahasthi and Rosado 2021; Lai and Locatelli 2021; Laldjebaev, Isaev and Saukhimov 2021; Khatiwada, Vasudevan and Santos 2022; Leonhardt et al. 2022)	(Lambert, Karvetski and Linkov 2011; Verschuuren 2013; de Almeida and Mostafavi 2016; Dawson et al. 2018; Helgeson and O'Rear 2018; Marto, Papageorgiou and Klyuev 2018; Arowolo et al. 2019; Farahmand et al. 2020; Osabuohien et al. 2021; Oviedo-Toral, François and Poganietz 2021; Stephenson, Sovacool and Inderberg 2021)
	Institutional capacity and administrative feasibility		B	(Bach, Hopkins and Stephenson 2020; Bautista-Puig and Sanz-Casado 2021; Beauchampet and Walsh 2021; Olawuyi 2021; Rahman and Wahid 2021; Smirnova et al. 2021)	(Verschuuren 2013; de Almeida and Mostafavi 2016; Dawson et al. 2018; Marto, Papageorgiou and Klyuev 2018; Arowolo et al. 2019; Kim et al. 2019; Farahmand et al. 2020; Osabuohien et al. 2021; Oviedo-Toral, François and Poganietz 2021)
	Transparency and accountability potential		NE	NE	(Farahmand et al. 2020; Marto et al. 2018; Stephenson et al. 2021)

Dimensions	Mitigation feasibility analysis	ENERGY DISTRIBUTION AND GENERATION			
		Evidence		Not assessed	
		Agreement		Not assessed	
		Dim. Avg	Indicator Score	References (update)	References (AR6/SR1.5)
Geophysical	Physical potential	2.5	C		(Calvert and Mabee 2015; Foxon et al. 2015; Capellán-Pérez, de Castro and Arto 2017; Green and Newman 2017; Poggi, Firmino and Amado 2018; Wiktorowicz et al. 2018)
	Geophysical resources		B		(Calvert and Mabee 2015; Capellán-Pérez, de Castro and Arto 2017; Newman, Beatley and Boyer 2017; Poggi, Firmino and Amado 2018; Wiktorowicz et al. 2018)
	Land use		N/A		
Environmental-ecological	Air pollution	2.25	C		(Clerici, Cova and Callegari 2015; Cameron et al. 2016; Balaban and de Oliveira 2017; Newman, Beatley and Boyer 2017; Rao and Pachauri 2017; Goldemberg et al. 2018; Rosenthal et al. 2018; Steenland et al. 2018)
	Toxic waste, ecotoxicity, eutrophication		B		(Foxon et al. 2015; Balaban and de Oliveira 2017; Newman, Beatley and Boyer 2017)
	Water quantity and quality		B		(Hejazi et al. 2015; Holland et al. 2015; Newman, Beatley and Boyer 2017; Wiktorowicz et al. 2018)
	Biodiversity		B		(Correa et al. 2017; Newman, Beatley and Boyer 2017; Wiktorowicz et al. 2018)
Technological	Simplicity	2	A		(Abi Ghanem and Mander 2014; Crispim et al. 2014; Giannantoni 2014; Zheng et al. 2014; Clerici, Cova and Callegari 2015; Derakhshan, Shayanfar and Kazemi 2016; Ramos et al. 2016; Otuoze, Mustafa and Larik 2018; Cabeza and Chàfer 2020)
	Technological scalability		C		(Connor et al. 2014; Crispim et al. 2014; Zheng et al. 2014; Derakhshan, Shayanfar and Kazemi 2016; Ramos et al. 2016; Guo et al. 2020; Usman et al. 2020)
	Maturity and technology readiness		B		(Abi Ghanem and Mander 2014; Crispim et al. 2014; Zheng et al. 2014; Clerici, Cova and Callegari 2015; Derakhshan, Shayanfar and Kazemi 2016; Palm and Reindl 2016; Ramos et al. 2016; Otuoze, Mustafa and Larik 2018)
Economic	Costs in 2030 and long term	2	B		(Crispim et al. 2014; Hall and Foxon 2014; Marques, Bento and Costa 2014; Muench, Thuss and Guenther 2014; Foxon et al. 2015; Akander, Cehlin and Moshfegh 2016; Bigerna, Bollino and Micheli 2016; Ramos et al. 2016; Schachter and Mancarella 2016; Ürge-Vorsatz et al. 2016; Makumbe 2017; Mofidi and Akbari 2017)
	Employment effects and economic growth		B		(Naus et al. 2014; Foxon et al. 2015; Shomali and Pinkse 2016; Niemelä et al. 2017; Barnes and Samad 2018; Thema et al. 2019)
Socio-cultural	Public acceptance	2.67	B		(Hall and Foxon 2014; Naus et al. 2014; Sagebiel and Rommel 2014; Bigerna, Bollino and Micheli 2016; Jung et al. 2016; Green and Newman 2017; Hansen and Hauge 2017; Kosorić et al. 2019; Koecklin et al. 2021)
	Effects on health and well-being		C		(Naus et al. 2014; Foxon et al. 2015; Hasegawa et al. 2015; Liddell and Guiney 2015; Shomali and Pinkse 2016; Hansen and Hauge 2017; Meadowcroft et al. 2018; Otuoze, Mustafa and Larik 2018)
	Distributional effect		C		(Green and Newman 2017; Neureiter 2017; Tonn, Rose and Hawkins 2018; Wiktorowicz et al. 2018)
Institutional	Political acceptance	1.67	B		(Crispim et al. 2014; Hall and Foxon 2014; Marques, Bento and Costa 2014; Naus et al. 2014; Bulkeley, McGuirk and Dowling 2016; Cohen et al. 2016; Jung et al. 2016; Shomali and Pinkse 2016; Vesnic-Alujevic, Breitegger and Pereira 2016; Meadowcroft et al. 2018)
	Institutional capacity and governance, cross-sectoral coordination		A		(Crispim et al. 2014; Hall and Foxon 2014; Marques, Bento and Costa 2014; Muench, Thuss and Guenther 2014; Clerici, Cova and Callegari 2015; Cohen et al. 2016; Ramos et al. 2016; Meadowcroft et al. 2018; Otuoze, Mustafa and Larik 2018; Koecklin et al. 2021)
	Legal and administrative feasibility		B		(Crispim et al. 2014; Marques, Bento and Costa 2014; Foxon et al. 2015; Bigerna, Bollino and Micheli 2016; Cohen et al. 2016; Koecklin et al. 2021)

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Annex 2

ANNEX: CLIMATE FINANCE FOR URBAN CLIMATE TECHNOLOGIES CASE STUDIES

E-Mobility

Company: Selex Motors
Country: Vietnam
Profile: Selex Motors aims to leverage data insights and cutting-edge technologies such as IoT, AI, and big data. Selex's goal is to make electric motorbikes accessible to everyone, contributing to a smarter and more sustainable mode of mobility. Selex's vehicles use battery swapping, and they are being adopted by well-known corporates in Vietnam such as Grab, Lazada Logistics and DHL Express, all of whom are committed to reducing their carbon footprint.

The Selex Motors product lineup includes:
- Selex Camel: An electric utility scooter tailored for cargo delivery
- Selex Camel 2: Designed for efficient passenger transport
- Cold Chain Storage: A cold box that can be attached to Selex's vehicles.Market expansion: Selex Motors is considering entry into the markets of Indonesia and Thailand within two years, both of which have larger economies than Vietnam.

Investment: Investors, including Schneider Electric Energy Access Asia, ADB Ventures and Vietnam's Touchstone Partners, have collectively injected USD 5.5 million into Selex Motors.

Green Buildings

Company: National Housing Authority
Country: Thailand
Profile: Thailand's National Housing Authority (NHA) has a mandate to develop affordable housing for low-income households. During the next five years (2022 to 2026), NHA plans to raise about USD 4 billion to fund 16 projects across the country that will serve hundreds of thousands of lower-income households (ADB 2022).

NHA's Sustainable Financing Framework: in September 2021, the NHA announced a new Sustainable Financing Framework that lays out principles and guidelines to ensure that the affordable housing and basic services provided by the NHA are accessible by all gender groups and are aligned with the UN's Sustainable Development Goals.

Green Housing in NHA's Sustainability Bond: NHA successfully issued a sustainability bond of USD 32 million in September 2021. This was the first sustainability bond issued by a state-owned enterprise in South-East Asia. The issue of the sustainability bond required the NHA to include evidence that its asset pool of housing meets international green building standards.

Cooling

Company: PAC Corporation (Thailand) Co., Ltd.
Country: Thailand
Profile: PAC Corporation Thailand is a women-led company based in Bangkok that specializes in creating innovative energy-saving cooling and heating products. With support from PFAN, the company has built a cost-effective financial model, developed an appealing business strategy, secured investments and raised capital.

Key innovation: PAC's patented product, PAC Frenergy, is Thailand's first energy-saving air conditioner and water heater. It utilizes the waste heat from air conditioners to produce hot water, reducing heat transfer to the atmosphere by 15 per cent and resulting in electricity savings of up to 80 per cent. PAC also has a range of energy-saving air conditioners, as well as ventilation solutions that improve indoor air quality.

Business model and value proposition: BrainBox AI's products leverage deep learning, cloud computing and custom algorithms, helping building owners to reduce their scope 1 and 2 emissions, while simultaneously decreasing energy costs. BrainBox AI's solution reduces HVAC-related carbon emissions by up to 40 per cent, reduces HVAC energy costs by up to 20 per cent and improves customer comfort by up to 60 per cent.

Investment: Brainbox has raised approximately USD 80 million to date and is planning to conduct another round of fundraising in late 2024. The most recent funding round, which raised USD 30 million, was led by ABB and the Government of Quebec and was completed in June 2023.

Business model and value proposition: In addition to its energy-saving water heaters and air conditioners, PAC provides energy-efficiency consulting services that target residential users, businesses, hospitality establishments and various industries, such as hotels, resorts, housing projects, hospitals, offices, factories and government buildings.

Internet-of-Things

Company: BrainBox AI Inc.

Country: Asia-Pacific

Profile: BrainBox AI utilizes advanced HVAC technology enhanced by AI to create smarter and more eco-friendly buildings. BrainBox AI's product offerings include an AI-based automated demand management and grid flexibility service, a carbon offset purchase platform and AI-driven supervisory control.

Solar Rooftop

Company: Fourth Partner Energy

Country: India

Profile: Fourth Partner received advisory coaching from PFAN during 2016 and 2017 when it was starting out. The company has since grown rapidly and now manages 1.35 GW of solar assets, comprising both distributed and rooftop solutions. They have expanded outside of India to launch ventures in Sri Lanka, Bangladesh, Indonesia and Vietnam.

Investment: Fourth Partner Energy received an equity investment of USD 42.3 million from Norfund in 2023 following a funding round of USD 125 million in June 2021. In addition, the International Finance Corporation (IFC) invested USD 67.6 million to support the rooftop installations and a solar park. Concurrently, The Rise Fund, an impact investing arm of TPG, invested an additional USD 25 million, following an earlier investment of USD 70 million in July 2018.

Future outlook: Fourth Partner Energy plans to continue its expansion across South and South-East Asia and to achieve 3.5 GW of installed solar capacity by 2025. Additionally, it is poised to diversify into energy storage and electric vehicle charging.

Circular Economy

Company: Binbag

Country: India

Profile: Binbag aims to develop a network of decentralized recycling hubs dedicated to e-waste throughout India. It currently operates two recycling units and plans to expand its reach across India through franchising and partnerships. Given the importance of smart-city schemes across India, waste management has become a priority of many city councils.

Investment: Binbag is seeking to raise financing with the assistance of PFAN. In June 2023, Binbag received a USD 120,000 investment from NEDFi Venture Capital in the form of a convertible note, bolstered by a prior credit facility of the same amount from the Ghalla Bhansali Group. Binbag is seeking an additional USD 240,000 to expand its operation in Assam, for hiring and product development. Challenges in fundraising: the company's primary challenge has been the lack of investor understanding of this sector. Most investors still look at climate tech start-ups with the same lens as software/SaaS companies, which makes it an uphill task to convince investors for capex funding.

Clean Water

Company: TapEffect

Country: Cambodia

Profile: a pressing concern in Cambodia is the lack of access to potable water. TapEffect manages multiple piped water systems, with each system covering thousands of people, along with connecting schools and healthcare facilities. They anticipate launching at least 10 systems in the next two years, with an ambition to expand to at least 180 systems by 2030.

Business model and value proposition: TapEffect constructs and operates piped water supply systems, operating with a B2C structure – developing the technology solutions for expansion into a B2B model and collaborating with established private water suppliers to maximize their reach. Their business addresses the immense, unmet demand for water in last-mile areas. They integrate closely with Cambodia's vast private supplier network to devise economically sustainable solutions.

Gender impacts and social inclusion: piped water solutions champion health and hygiene, and alleviate the water collection burdens traditionally shouldered by women and girls.

Investment: TapEffect is raising both debt and equity investment for expansion to at least 10 systems and growth of the business, with an emphasis on technological development for efficient operations.

Industrial Logistics

Company: WorldBridge Industrial Developments

Country: Cambodia

Profile: the WorldBridge Group is at the forefront of Cambodia's technological and socioeconomic evolution, having initiated ACT5, an Industry 4.0 Cluster. ACT5's geographic concentration provides small and medium-sized enterprises with three key advantages:

1. access to resilient, eco-friendly infrastructure at affordable rates
2. a platform for knowledge sharing and capacity building and
3. access to state-of-the-art digital IoT, R&D, and logistics to bolster business success within Cambodia.

Value proposition: the ACT5 ecosystem is aligned with ESG principles and offers companies a competitive edge, advocating for ethical supply chain practices, skills enhancement for the workforce and prioritizing health, safety and overall well-being.

Investment: in 2020, the WorldBridge Group made an initial capital investment of USD 6 million for the inception of ACT5. This amount covered market analysis, drafting the technical design, and constructing the cluster's preliminary facilities and infrastructure. To complete their first 6-hectare cluster, which aims to accommodate 20 enterprises in agro-processing, waste management and recycling, WorldBridge is raising USD 16 million from impact investors and development financing institutions.