Fails to meet criteria	Not promising	Meets in some respects	Potentially meets criteria	Meets criteria

* For explanation of criteria see Box B, page 22

ASSESSMENT TABLE: **Cement**

	Credible			Capable		Compelling			Priority approach
	Maturity	Economic viability	Social acceptability	Fit for purpose	Net-zero pathway potential	To critical stakeholders	Related costs and benefits	Economic development opportunities	
Alternative fuels									
Biomass and/or waste	Already being applied at scale. But challenges moving to 100% alternative fuels (eg: lower calorific value of biofuels as compared to fossil fuels).	Depends on fuel sources Today less expensive than contemplating electrification or hydrogen but more expensive than traditional fuels	Could be concerns over air pollution and waste incineration and transport of solid fuel	Yes in principle.	Yes, for energy emissions if biomass is sustainably harvested. Some fuels from waste emit GHGs (eg tires, asphalt shingles, etc), so requires full lifecycle analysis to verify net zero emission credentials of waste fuels. Must be combined with approach to manage process emissions	Currently easiest option to substitute for fossil fuels in kiln heating	Can use local biomass or waste streams Competing uses of biomass in net zero economy. Air emissions	Some for local enterprises producing biomass or managing waste streams	Medium/High For further R&D and pilots
Electrification of heat	Several alternatives at research and development stage. Preparations underway for pilot using plasma technology	Depends on availability of cheap low carbon electricity.	No particular issues (but related to source of low carbon electricity)	In principle high	Assuming decarbonized electricity, high for energy emissions. But must be combined with approach to manage process emissions	Interest where low carbon electricity is available and strong carbon commitments.	No air pollution. Large electricity requirement, so there may be competing uses for low carbon electricity.	Particularly for firms that secure breakthrough technology.	Medium high. For further R&D and pilots. Especially in areas with plentiful decarbonized electricity
Hydrogen	At research and development stage. Kiln redesign for 100% hydrogen. Some pilots being explored	Depends on availability of cheap low carbon hydrogen	No particular issues	Yes, in principle	High for energy emissions. But must be combined with approach to manage process emissions	Interest where hydrogen sources may become available	No air pollution	Particularly for firms that capture breakthrough technology.	High. Could be integrated into a broader hydrogen economy
Hybrid approaches	At research and development stage. Some pilots being planned	Difficult to determine. Uses some mix of biomass and/or electricity and/or hydrogen. Could allow adjustment to lowest cost fuel mix	No particular issues.	Yes, in principle	Yes, in principle. But must be combined with approach to manage process emissions		Depends on hybrid mix	Depends on hybrid mix	Medium

Fails to meet criteria	Not promising	Meets in some respects	Potentially meets criteria	Meets criteria

ASSESSMENT TABLE: **Cement**

* For explanation of criteria see Box B, page 22

	Credible			Capable		Compelling			Priority approach
	Maturity	Economic viability	Social acceptability	Fit for purpose	Net-zero pathway potential	To critical stakeholders	Related costs and benefits	Economic development opportunities	
Low carbon cements									
Substitution of clinker	Varies according to materials to be substituted to reduce clinker proportion.	Costs range considerably	No particular issues	Yes, in some cases strengthens or otherwise improves product	Possible but limited as clinker emissions cannot be eliminated while cement chemistry remains the same. Process emissions must be combined with energy emissions reductions.	Medium	Depends on the alternative used. In case of using waste materials, industrial waste that goes to landfill can be reduced	Medium	Medium
Changing cement chemistries	Alternative chemistries at different levels of development	Vary with chemistry, availability of feedstocks and still hard to determine	No particular issues	Yes in principle	Yes, but depends on new which new chemistry is adopted. Energy requirements may vary	Not yet clear	Not yet clear, depends on alternative	Not yet clear, depends on alternative	Medium/High Important and could substantially decarbonize sector, but long R&D road ahead.
Carbon capture, utilization and storage									
	Feasibility study to equip an Edmonton plant is ongoing. Multiple pilots being pursued in US and Europe	With carbon pricing CCS potentially economic but high upfront capital costs	No particular issues	Yes, for both energy and process emissions. Could be coupled with part biomass combustion to remove need for external offsets (as capture rate is less than 100%)	Most analysts assume an essential element to get cement to net zero. Can capture 90% of process emissions and possibly other emissions. Requires suitable storage sites (excellent in Western Canada)	Yes, as it allows continued use of existing cement chemistries	Captured CO2 can be injected into concrete to strengthen it. Other uses possible. But scale of industry suggests underground sequestration will be required	Can lik to broader applications across economy including hydrogen production	High