Clyde Mission

Heat Decarbonisation Fund

Appendix B

Technology Benefits Realisation Framework

Scottish Government
Riaghaltas na h-Alba

Argyll Bute COUNCIL

GLASGOW CITY REGION

Technology	OUTCOMES (project level)			OUTPUTS (project level)	IMPACTS (programme level)
	Heat Generation	Carbon Reduction	Energy Cost Savings		
Heat Pumps (air, ground, water, minewater, wastewater, sewer)	Annual renewable heat delivered (MWh/yr)	High: Replaces fossil fuel use with low-carbon heat for majority of heat demand	High: Overall cost of energy (i.e. heat and electricity) reduced by combining heat pumps with complementing technologies e.g. solar PV panels, thermal stores, and/or electricity agreements to agree lower costs of energy.	Annual renewable heat delivered (MWh), if applicable: annual renewable electricity delivered (MWh)	Significant CO_2 reduction through fossil boiler replacement with heat pumps
	Number of buildings connected	Medium: Partial displacement of fossil fuels, e.g., for space heating only.	Medium: Cost of energy is actively managed through measures such as electricity tariff selection, checking and optimising the performance of the system through commissioning and tools such as a Building Energy Management System (BEMS)	Number of buildings connected	Cost of energy managed by integrating heat pumps with complementary techologies such as solar PV and/or agreements such as smart tariffs
	Installed capacity (MWth)	Low: Minimal CO2 reduction due to small-scale installation or heat supply mix at an energy centre or plant room which is heavily weighted towards fossil-fuel use.	Low: Cost of heat is equivalent to operational and maintenance costs of heat pump system. I.e. roughly equivalent to cost of electricity to run heat pumps plus regular operation and maintenance costs of the heat supply system. I.e. where the business as usual (BAU) includes natural-gas boilers, the cost of heat with heat pumps may be higher than the BAU case.	Heat pump capacity (MW), if applicable: installed capacity of complementary technology such as solar PV (MW)	Future-proofed low-carbon heat supply with heat pumps
Waste Heat Recovery (industrial, data centres, sewage, etc.)	Recovered heat (MWh/yr)	High: Captures and utilises a significant amount of waste heat that would otherwise be lost.	High: Overall cost of energy (i.e. heat and electricity) reduced by combining with complementing technologies (e.g. solar PV panels, thermal stores, and/or electricity agreements to agree lower costs of energy).	Annual waste heat delivered (MWh)	Long-term regional energy security and waste reduction
	Waste heat recovery typology, e.g. industrial process heat recovery, data-centre, wastewater, or other heat supply source	Medium: Moderate heat capacity and/or moderate availability of waste heat supply	Medium: Cost of energy is actively managed through measures such as electricity tariff selection, checking and optimising the performance of the system through commissioning and tools such as a Building Energy Management System (BEMS)	Type and number of waste heat supply connections	Locating low-carbon heat networks in areas with waste heat available such as industrial clusters
		Low: Limited capacity and/or low availability of waste heat supply	Low: Cost of heat is equivalent to operational and maintenance costs of the heat supply system. I.e. where the business as usual (BAU) includes natural-gas boilers, the cost of heat from waste heat recovery may be higher than the BAU case.	Annual waste heat recovered (MWh)	Contribution to circular economy

Technology	OUTCOMES (project level)			OUTPUTS (project level)	IMPACTS (programme level)
	Heat Generation	Carbon Reduction	Energy Cost Savings		
Energy from Waste (EfW) Waste Processing Facility (WPF) as heat source	Heat exported (MWh/yr)	High: Captures and utilises a significant amount of heat from the EfW process	High: Overall cost of energy (i.e. heat and electricity) reduced by combining with complementing technologies (e.g. solar PV panels, thermal stores, and/or electricity agreements to agree lower costs of energy).	Continuous baseload heat delivered (MW)	EfW as reliable baseload supply for district heating
	Heat baseload capacity (MWh)	Medium: Moderate heat capacity and/or moderate availability of waste heat supply	Medium: Cost of energy is actively managed through measures such as electricity tariff selection, checking and optimising the performance of the system through commissioning and tools such as a Building Energy Management System (BEMS)	Number of buildings connected	Long-term energy security for the region, and grid stability via EfW electricity generation integration
	Network length (km)	Low: Limited impact due to capacity and scale or availability i.e. feedstock issues.	Low: Cost of heat is equivalent to operational and maintenance costs of the heat supply system. I.e. where the business as usual (BAU) includes natural-gas boilers, the cost of heat from waste heat recovery may be higher than the BAU case.	Tonnes of waste diverted from landfill	Alignment with waste management strategy
Biogas / Anaerobic Digestion (AD)	Renewable heat produced (MWh/yr)	High: Renewable fuel fully displaces fossil gas.	High: Overall cost of energy (i.e. heat and electricity) reduced by combining with complementing technologies (e.g. solar PV panels, thermal stores, and/or electricity agreements to agree lower costs of energy).	Renewable biogas utilised (MWh/yr)	Full displacement of fossil gas where feedstock is secured
	Feedstock processed (t/yr)	Medium: Moderate heat capacity and/or partial substitution of fossil gas due to feedstock limitations.	Medium: Cost of energy is actively managed through measures such as electricity tariff selection, checking and optimising the performance of the system through commissioning and tools such as a Building Energy Management System (BEMS)	Tonnes of organic waste diverted from landfill	Strengthened rural and agricultural economies
		Low: Limited impact due to capacity and scale or availability i.e. feedstock issues.	Low: Cost of heat is equivalent to operational and maintenance costs of the heat supply system. I.e. where the business as usual (BAU) includes natural-gas boilers, the cost of heat from using biogas may be higher than the BAU case.	Number of agricultural/industrial sites served	Circular economy through waste-to-energy /waste minimisation
Solar Thermal	Annual solar yield (MWh/yr)	High: Supplies most DHW demand; reduces seasonal fossil fuel use.	High: Significantly reduces energy bills for hot water.	Annual renewable heat delivered (MWh/yr)	Seasonal (summer) heat supply from solar thermal
	Percent of annual heat load met (space heating and domestic hot water (DHW))	Medium: Partial contribution; only peak summer savings.	Medium: Moderate savings; seasonal impact.	Percent of annual heat load met (space heating and domestic hot water (DHW))	Visible, community-facing renewable technology
	Collector area (m^2)	Low: Minimal carbon reduction for small or shaded installations.	Low: Minimal financial impact.	Installed collector area (m^2)	Educational/social benefits
				No. of building retrofits/installs	

Technology	OUTCOMES (project level)			OUTPUTS (project level)	IMPACTS (programme level)
	Heat Generation	Carbon Reduction	Energy Cost Savings		
Thermal Storage (e.g., hot water tanks, borehole thermal energy storage)	Storage capacity (MWh)	High: Enables higher renewable integration indirectly.	High: Reduces peak demand charges; optimises energy use.	Installed storage capacity (MWh)	Enhanced flexibility and resilience
		Medium: Partial carbon reduction via load-shifting.	Medium: Some cost benefits from partial load-shifting.	No. of buildings/heat networks with storage	Supports integration of renewables into grid/heat systems
			Low: Limited financial benefit.		Greater local energy resilience
					Enables future net-zero pathways
Electricity-to-Heat (PV, Wind linked to heat decarbonisation package)	Renewable capacity (MW)	High: Significant capacity heat supply from electricity-to-heat renewables (e.g. solar PV/Wind), plus energy storage (e.g. thermal store and/or battery) (MWh/yr)	High: Significant cost of heat savings, comparing the operational heat supply cost with and without electricity-to-heat technology (e.g. consider cost savings found by reducing amount of electricity used from the electricity grid compared to utilising assets such as PV and wind).	Annual renewable electricity-to-heat delivered (MWh/yr)	Reduced imported electricity from the electricity grid and exposure to volatile electricity prices
	Electricity-to-heat output (MWh/yr)	Medium: Moderate capacity heat supply from electricity-to-heat renewables (e.g. solar PV/Wind), plus energy storage (e.g. thermal store and/or battery) (MWh/yr)	Medium: Moderate cost of heat savings, comparing the operational heat supply cost with and without electricity-to-heat technology (e.g. consider cost savings found by reducing amount of electricity used from the electricity grid compared to utilising assets such as PV and wind).	Capacity of renewables integrated into heating systems (MW)	Direct substitution of fossil fuels with renewable electricity
	Storage (MWh) - thermal and/or battery	Low: Limited capacity of heat supply from electricity-to-heat renewables (e.g. solar PV/Wind) (MWh/yr)	Low: Limited cost of heat savings, comparing the operational heat supply cost with and without electricity-to-heat technology (e.g. consider cost savings found by reducing amount of electricity used from the electricity grid compared to utilising assets such as PV and wind).	Number of hybrid/backup systems installed	Supports visibility and adoption of local green energy

Technology	OUTCOMES (project level)			OUTPUTS (project level)	IMPACTS (programme level)
	Heat Generation	Carbon Reduction	Energy Cost Savings		
District Heating (new, extension of heat network, or retrofit with connection of additional buildings)	Annual heat supplied (MWh/yr)	High: Large-scale decarbonisation across multiple buildings.	High: Economic viability of the heat network is promising with lower-cost heat sources and/or reasonable Linear Heat Density (LHD) of building connections (where LHD is the ratio of annual heat demand to district heat network trench length).	Annual heat delivered (MWh/yr)	Large-scale decarbonisation across communities
	Peak heat capacity (MW)	Medium: Medium-scale decarbonisation.	Medium: Economic viability of the heat network and cost of energy is actively managed through measures such as seeking to add building connections to increase heat network heat demand (and therefore incoming revenue from heat sales) electricity tariff selection, checking and optimising the performance of the system through commissioning and other means.	Households benefitting from reduced heating bills	Long-term urban infrastructure for Net Zero
	No of connections	Low: Small-scale or isolated deployment.	Low: Cost of heat is equivalent to operational and maintenance costs of district heating system. I.e. operation and maintenance costs. Where the business as usual (BAU) includes natural-gas boilers, the cost of heat with district heating may be higher than the BAU case.	No. of buildings/households connected	Supports economic regeneration in Clyde corridor
	Network length (km)			Network length installed (km)	