- market; A. Shpitsberg, "Corporate renewable procurement pushing solar and wind deployment", HIS Markit, 27 September 2019, https://ihsmarkit.com/research-analysis/corporate-renewable-procurement-pushing-solar-and-wind-deploym.html; S. Dunlop, Senior Policy Adviser, SolarPower Europe/RE-Source Platform, "Companies going for 100% renewables in Europe", presentation, 2019, https://www.renewable-ei.org/pdfdownload/activities/ Keynote_SoniaDunlop_EN.pdf; F. Simon, "Calls grow for EU-wide certificates to boost market for 'green gas'", Euractiv, 3 October 2019, https://www.euractiv.com/section/energy/news/calls-grow-for-eu-wide-certificates-to-boost-market-for-green-gas; Green Gas Certification Scheme, "Additionality", https://www.greengas.org.uk/certificates/additionality, viewed 16 December 2020.
- 53 United States from A. Rotatori and C. Bonugli, "Mapping out Charlotte's lead on green tariffs", GreenBiz, 5 March 2020, https://www.greenbiz.com/article/mapping-out-charlottes-lead-green-tariffs. In Europe, the market is focused almost entirely on corporate purchases, from Simon, op. cit. note 52.
- 54 US EPA, "Green power communities", https://www.epa.gov/ greenpower/green-power-communities, updated 27 July 2020.
- 55 City of Charlotte, "Green Source Advantage Program Solar Energy Project", https://charlottenc.gov/sustainability/seap/ Pages/Green_Source_Advantage.aspx, viewed 17 December 2020; City of Charlotte, "Strategic Energy Action Plan", https:// charlottenc.gov/sustainability/seap/Pages/default.aspx, viewed 17 December 2020.
- 56 Simon, op. cit. note 52.
- 57 Ibid.; M. Perez, "As demand for 'green' power soars utilities turn to Guarantees of Origin", S&P Global Platts, 7 August 2019, https://blogs.platts.com/2019/08/07/ eu-green-electricity-guarantees-of-origin.
- I. M. Poxton, "Borough buildings and street lights will switch to 100% renewable energy", Bedford Independent, 25 November 2020, https://www.bedfordindependent.co.uk/borough-buildings-andstreet-lights-to-run-on-100-green-renewable-energy-from-2021.
- 59 See information and sources throughout this section.
- 60 Shaver, "Watch these 4 clean energy trends in U.S. cities in 2020", op. cit. note 8; S. Enkhardt, "Europe has now 8.4 GW of planned and built PV projects under PPAs", pv magazine, 29 January 2020, https://www.pv-magazine.com/2020/01/29/europe-has-now-8-4-gw-of-planned-and-built-pv-projects-under-ppas; M. Lempriere, "City of London Corporation signs first of its kind £40m PPA for Dorset solar site", Solar Power Portal, 18 November 2020, https://www.solarpowerportal.co.uk/news/city_of_london_corporation_signs_first_of_its_kind_40m_ppa_for_dorset_solar.
- See, for example: N. Filatoff, "Solar auctions to spread PV over the commercial landscape", pv magazine, 28 September 2020, https://www.pv-magazine.com/2020/09/28/solar-auctions-to-spread-pv-over-the-commercial-landscape; S. Djunisic, "Iberdrola signs corporate PPA for 100 MW of PV for on-site consumption", Renewables Now, 29 July 2020, https://renewablesnow.com/news/iberdrola-signs-corporate-ppa-for-100-mw-of-pv-for-on-site-consumption-708114; Enel Green Power, "Enel Green Power connects a 51 MW wind farm to the grid in Cuenca", press release (Cuenca: 7 August 2020), https://www.enelgreenpower.com/media/press/2020/08/enel-green-power-connects-a-51-mw-wind-farm-to-the-grid-in-cuenca.
- 62 See information and sources throughout this section.
- 63 Data for beginning of 2015 through first quarter of 2020, from Gonçalves and Liu, op. cit. note 12.
- 64 Calculated based on data for transaction announcements made during 2019 and through 30 June 2020, including 56 off-site physical PPAs and one off-site virtual PPA, from S. Abbott et al., "Local Government Renewables Action Tracker", https://cityrenewables.org/local-government-renewables-action-tracker, viewed 6 October 2020. Transactions are defined as electricity purchases and deals linked to specific renewable energy projects; "local government" includes cities, counties and tribal governments.
- 65 City of Los Angeles, "Mayor Garcetti celebrates final approval of largest solar and energy storage project in America", press release (Los Angeles: 6 November 2019), https://www.lamayor.org/mayor-garcetti-celebrates-final-approval-largest-solar-and-energy-storage-project-us; E. Misbrener, "8 Minute Solar Energy approved to build 400-MW solar+storage project for City of Los Angeles", Solar Power World, 10 September 2019, https://www.solarpowerworldonline.com/2019/09/8minute-solar-energy-los-angeles-solar-storage.

- Shaver, "Watch these 4 clean energy trends in U.S. cities in 2020", op. cit. note 8; City of Cincinnati, "Cincinnati to construct nation's largest solar project", press release (Cincinnati, OH: 21 November 2019), https://www.cincinnati-oh.gov/mayor/news/cincinnatito-construct-nation-s-largest-city-led-solar-project; W. Peischel, "The biggest municipal solar farm coming to...Cincinnati?", Mother Jones, 10 February 2020, https://www.motherjones.com/ environment/2020/02/the-biggest-municipal-solar-farm-in-theus-is-coming-to-cincinnati; "Alabama Municipal Electric Authority signs 100-MW solar PPA", Renewable Energy World, 29 May 2019, https://www.renewableenergyworld.com/2019/05/29/alabamamunicipal-electric-authority-signs-100mw-solar-ppa; C. Shahan, "New Sun Tribe solar project will cover 10% of Pennsylvania borough's electricity use", CleanTechnica, 30 May 2020, https:// cleantechnica.com/2020/05/30/new-sun-tribe-solar-project-willcover-10-of-pennsylvania-boroughs-electricity-use.
- G. Holmes, "Major solar energy project begins operation in Central Florida", Florida Municipal Electric Association, 30 June 2020, https://www.publicpower.com/news/major-solar-energy-project-begins-operation-in-central-florida; E. Rosen, "2 new solar farms to deliver power to 6 Florida cities, including Orlando and Kissimmee", MSN, 22 June 2020, https://www.msn.com/en-us/news/us/2-new-solar-farms-to-deliver-power-to-6-florida-cities-including-orlando-and-kissimmee/ar-BB15Q0PF.
- 68 Rosen, op. cit. note 67.
- 69 Tenders Electronic Daily, "Place of performance (Map)", https://ted.europa.eu/TED/search/searchResult.do, viewed 12 December 2020. CPV used: 09332000; 09331000; 09330000; 09331100; 09331200; 45261215.
- To London's solar PPA will help save the City Corporation of London around GBP 3 million (USD 4.1 million) in energy costs over its lifetime, and provide half of its electricity demand. The PPA will help power buildings such as the Corporation's historic Guildhall headquarters, three wholesale markets and the Barbican arts centre. From Lempriere, op. cit. note 60. Enel Green Power, op. cit. note 61; Reve, "Andberg wind farm finds power offtaker", Renews, 1 October 2019, https://renews.biz/55606/andberg-wind-farm-finds-power-offtaker; EV Wind, "Wind energy in Sweden, First wind farm to utilize Nordex N149/5.X wind turbines", 10 January 2020, https://www.evwind.es/2020/01/10/wind-energy-in-sweden-first-wind-farm-to-utilize-nordex-n149-5-x-wind-turbines/73005.
- 71 B. Coyne, "Bristol Airport switches to 100 per cent renewable power via Ørsted", The Energyst, 13 September 2019, https://theenergyst.com/bristol-airport-switches-to-100-per-cent-renewable-power-via-orsted; S. Djunisic, "Bristol Energy inks PPA with Thrive for 3.55 MW of wind turbines", Renewables Now, 24 July 2019, https://renewablesnow.com/news/bristol-energy-inks-ppa-with-thrive-for-355-mw-of-wind-turbines-662749; A. Durakovic, "German airport operator seeks offshore wind power", Offshore WIND, 8 June 2020, https://www.offshorewind.biz/2020/06/08/german-airport-operator-seeks-offshore-wind-power.
- 72 M. Maisch, "City of Adelaide switches to 100% renewable electricity", pv magazine, 1 July 2020, https://www.pv-magazine-australia.com/2020/07/01/city-of-adelaideswitches-to-100-renewable-electricity; A. Danigelis, "City of Adelaide powers operations with 100% renewable energy", Environment + Energy Leader, 2 July 2020, https://www.environmentalleader.com/2020/07/adelaide-renewable-energy-operations; City of Melbourne, "Melbourne Renewable Energy Project: A new generation of energy", https://www.melbourne.vic.gov.au/business/sustainable-business/mrep/Pages/melbourne-renewable-energy-project.aspx, viewed 17 December 2020; Energetics, "Melbourne Renewable Energy Project 2.0", July 2020, https://www.energetics.com.au/projects/melbourne-renewable-energy-project-20.
- 73 S. Wray, "Sydney switches to 100 percent renewable energy", CitiesToday, 6 July 2020, https://cities-today.com/sydneyswitches-to-100-percent-renewable-energy; City of Sydney, "5 things to know about our electricity deal", https://news. cityofsydney.nsw.gov.au/articles/5-things-to-know-aboutour-electricity-deal, viewed 8 February 2021. See also S. Hanley, "City of Sydney goes 100% renewable", CleanTechnica, 3 July 2020, https://cleantechnica.com/2020/07/03/ city-of-sydney-goes-100-renewable.
- 74 See, for example: I. B. Ruiz "Cities leading the transition to renewables", DW, 9 March 2018, https://www.dw.com/en/cities-leading-the-transition-to-renewables/a-42850621; L. Shaver and

- H. House, "INSIDER: Beyond buying renewables: How cities can influence the energy system", WRI Blog, 27 July 2020, https://www.wri.org/blog/2020/07/insider-beyond-buying-renewables-how-cities-can-influence-energy-system; Duncan and Bonugli, op. cit. note 9.
- 75 Sustainable Energy Africa (SEA), State of Energy in South African Cities Report 2020 (Cape Town: 2020), http://www.cityenergy.org. za/uploads/resource_508.pdf; Business Insider South Africa, "Big breakthrough: Some municipalities can now generate their own electricity", 16 October 2020, https://www.businessinsider.co.za/ some-municipalities-can-procure-their-own-electricity-2020-10.
- 76 Ibid
- 77 See, for example: J. Duncan, "A new era for local governments and public utility commissions: The city perspective", IMT, 9 July 2019, https://www.imt.org/a-new-era-for-local-governmentsand-public-utility-commissions-the-city-perspective; Shaver and House, op. cit. note 74.
- 78 D. Ribeiro et al., The 2020 City Clean Energy Scorecard (Washington, DC: American Council for an Energy-Efficient Economy, October 2020), p. 29, https://www.aceee.org/sites/ default/files/pdfs/u2008.pdf.
- 79 C. Etter-Wenzel and L. Shaver, "Despite challenges, Virginia cities envision a bold clean energy future", WRI Blog, 29 August 2019, https://www.wri.org/blog/2019/08/despite-challenges-virginiacities-envision-bold-clean-energy-future.
- 80 M. Banker, S. Abbott and A. Rotatori, "The Clean Economy Act is a breakthrough for Virginia and the South", Rocky Mountain Institute (RMI), 15 April 2020, https://rmi.org/the-clean-economy-act-is-a-breakthrough-for-virginia-and-the-south.
- 81 See, for example, K. Uhlenhuth, "Kansas City clean energy goals could get a boost from utility partnership", Energy News Network, 3 May 2018, https://energynews.us/2018/05/03/midwest/kansascity-clean-energy-goals-could-get-a-boost-from-utility-partnership.
- 82 S. Abbott, "What good are city clean-energy targets?" RMI, 12 August 2019, https://rmi.org/what-good-are-city-clean-energy-targets; Duncan and Bonugli, op. cit. note 9.
- 83 Minneapolis Clean Energy Partnership, "About the partnership", https://mplscleanenergypartnership.org/about, viewed 17 December 2020. In 2018, Kansas City (Missouri) was working with local utility to achieve several of its clean energy goals; the city aims to set example for local businesses and institutions to follow. From Uhlenhuth, op. cit. note 81. See also Abbott, op. cit. note 82.
- 84 Duncan and Bonugli, op. cit. note 9. Breckenridge, Colorado also entered into a memorandum of understanding with Xcel in 2018 to achieve its 100% renewable goal, from Town of Breckenridge, "Town of Breckenridge approves a Memorandum of Understanding with Xcel Energy", press release (Breckenridge, CO: 24 January 2018), https://www.townofbreckenridge.com/Home/Components/News/News/1932.
- 85 Salt Lake City, "Utah communities celebrate landmark renewable energy legislation", SLC Blog, 22 April 2019, https://www.slc.gov/blog/2019/04/22/utah-communities-celebrate-landmark-renewable-energy-legislation. Salt Lake City and Park City both set 100% clean energy commitments in 2016, from Abbott, op. cit. note 82. See also J. Van Horn, "Salt Lake City announces 100% clean energy goal", Sierra Club, 15 July 2016, https://www.sierraclub.org/compass/2016/07/salt-lake-city-announces-100-clean-energy-goal, and The Climate Reality Project, "Park City signs 100% renewable electricity pledge", EcoWatch, 11 October 2016, https://www.ecowatch.com/park-city-utah-renewable-energy-2040100564.html.
- I. García and D. Khandke, Cities and Civil Society as Allies for the Energy Transition (Washington, DC: German Marshall Fund of the United States, 2019), https://www.gmfus.org/sites/default/ files/Energy%20Allies.pdf; SWM, "SWM: A company for Munich", https://www.swm.de/english/company, viewed 15 December 2020.
- 87 Siemens Gamesa, "DanTysk for Munich", https://www. siemensgamesa.com/en-int/explore/customer-references/ dantysk-offshore-wind-farm, viewed 15 December 2020.
- 88 Abbott, op. cit. note 82; J. Farrell, "Voices of 100%: Michigan city sets steady pace to a clean electricity goal", CleanTechnica, 4 May 2020, https://cleantechnica.com/2020/05/04/voices-of-100-michigan-city-sets-steady-pace-to-a-clean-electricity-goal.
- 89 M. Motyka, "Renewables (em)power smart cities", Deloitte, 5 March 2019, https://www2.deloitte.com/xe/en/insights/industry/ power-and-utilities/smart-renewable-cities-wind-solar.html.

- See Citizen Participation chapter for more information and sources. Cities that have debated municipalisation include, for example, Boulder (Colorado), from "'Municipalization' of the Boulder electric utility: What happens when aspirational policy goals and complex realities collide - and a lesson for others", Velocity Public Affairs, 3 April 2019, https://velocitypublicaffairs. com/2019/04/03/municipalization-of-the-boulder-electric-utilitywhat-happens-when-aspirational-policy-goals-and-complexrealities-collide-and-a-lesson-for-others, and Chicago (Illinois), from Office of the Mayor, "City of Chicago releases findings of preliminary municipal utility feasibility study: Study finds that municipalization of electric utility is not financially viable", press release (Chicago, IL: 28 August 2020), https://www.chicago. gov/city/en/depts/mayor/press_room/press_releases/2020/ august/MunicipalUtilityFeasibilityStudy.html. See also L. Ambort, "Spreading like wildfire: An interest in making electric power public", Institute for Local Self-Reliance, 5 March 2020, https:// ilsr.org/municipalization-electric-utilities-update-2020.
- 91 Barcelona Energia, "Barcelona Energia, the metropolitan electricity company", https://energia.barcelona/en/barcelonaenergia-municipal-electricity-company, viewed 17 December 2020.
- 92 Ibid.; Transformative Cities, "Barcelona Energia", https://
 transformativecities.org/atlas/atlas-013, viewed 17 December
 2020; Ajuntament de Barcelona, "Barcelona Energia flicks
 the switch", press release (Barcelona: 30 June 2018), https://
 www.barcelona.cat/infobarcelona/en/tema/environment-andsustainability/barcelona-energia-flicks-the-switch_683855.html.
- 93 Barcelona Energia, op. cit. note 91; Ajuntament de Barcelona, op. cit. note 92.
- S. Becker, M. Naumann and T. Moss, "Between coproduction and commons: Understanding initiatives to reclaim urban energy provision in Berlin and Hamburg", Urban Research & Practice, vol. 10, no. 1 (2017), pp. 63-85, https://www.tandfonline.com/doi/ abs/10.1080/17535069.2016.1156735; D. Q. Ilkhani and E. Woertz, Remunicipalisation of Local Energy Provision: The Role of Cities and Bottom-up Initiatives (Barcelona: CIDOB, May 2019), https://www. cidob.org/en/publications/publication_series/cidob_policy_brief/ remunicipalisation_of_local_energy_provision_the_role_of_cities_ and_bottom_up_initiatives; Transnational Institute et al., Reclaiming Public Services: How Cities and Citizens Are Turning Back Privatization (Amsterdam and Paris: June 2017), https://www.tni.org/ $files/publication-downloads/reclaiming_public_services.pdf; \textbf{C}.$ Morehouse, "Chicago considers municipalizing ComEd", Utility Dive, 25 July 2019, https://www.utilitydive.com/news/chicago-considersmunicipalizing-comed/559505; City of Chicago, Office of the Mayor, "City of Chicago releases findings of preliminary municipal utility feasibility study", press release (Chicago, IL: 28 August 2020), https://www.chicago.gov/city/en/depts/mayor/press_room/ press_releases/2020/august/MunicipalUtilityFeasibilityStudy.html; G. Bade, "San Francisco considering municipal utility as PG&E prepares bankruptcy filing", Utility Dive, 15 January 2019, https:// www.utilitydive.com/news/san-francisco-considering-municipalutility-as-pge-prepares-bankruptcy-fil/546087.
- 95 Total electricity share based on estimated global electricity generation of 27,000 TWh in 2019, from REN21, op. cit. note 5, p. 47; K. C. Seto et al., "Human settlements, infrastructure and spatial planning", in O. Edenhofer et al., eds., Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge, UK and New York, NY: Cambridge University Press, 2014), https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter12.pdf.
- 96 Estimate of 27.3% from Ibid., p. 47.
- 97 CDP-ICLEI Unified Reporting System, "Cities renewable energy targets", https://data.cdp.net/browse?category=Renewable%20 Energy, viewed 4 January 2021.
- 98 Ibid.
- 99 Ibid.
- 100 US Department of Energy, Energy Information Administration, Electric Power Monthly with Data for December 2020 (Washington, DC: February 2021), https://www.eia.gov/electricity/monthly/ archive/February2021.pdf.
- 101 CDP, CDP Cities 2017 Information Request: City of Houston, 12 June 2017, www.greenhoustontx.gov/reports/CDP-Cities-2017. pdf; City of Houston, Resilient Houston (Houston, TX: February 2020), www.greenhoustontx.gov/reports/Resilient-Houston.pdf;

- City of Houston, "The City of Houston commits to 100% renewable energy", press release (Houston, TX: 30 April 2020), http://www.greenhoustontx.gov/pressrelease20200430.html.
- 102 Austin Energy, "Renewable power generation", https:// austinenergy.com/ae/about/environment/renewable-powergeneration, viewed 30 November 2020; 37.5% in 2018 from CDP data received October 2020.
- 103 REN21 Policy Database (2020), available at www.ren21.net/cities/datapack. Data are compiled by REN21 and based on CDP-ICLEI Unified Reporting System, CDP Open Data, The Global 100% Renewable Energy Platform, Climate Action Network, C40, ICLEI, IRENA, Sierra Club, UK100 and REN21 data collection. Some research is based on voluntary reporting and therefore may not be exhaustive. See also M. Navarro, "City issues rule to ban dirtiest oils at buildings", New York Times, 21 April 2019, https://www.nytimes.com/2011/04/22/nyregion/new-york-city-bans-dirtiest-heating-oils-at-buildings.html.
- 104 Based on IRENA, op. cit. note 4.
- 105 Solvay, "One Planet: Solvay Asia is getting a renewable energy boost!" 27 February 2020, https://www.solvay.com/en/article/one-planet-solvay-asia-getting-renewable-energy-boost; Solvay, "Powering up with increasingly green energy", 21 February 2019, https://www.solvay.com/en/article/increasing-green-energy; B. Epp, "Demand for central solar water heating peaks in 2019", solarthermalworld.org, 23 March 2020, https://www.solarthermalworld.org/news/demand-central-solar-water-heating-peaks-2019.
- 106 B. Epp, "50 new solar hot water systems at Turkish prisons in three years", solarthermalworld.org, 22 August 2020, https:// www.solarthermalworld.org/news/50-new-solar-hot-watersystems-turkish-prisons-three-years.
- 107 Sonnenhaus Institut, "Erstes Mehrfamilien-Sonnenhaus in Regensburg ist bezugsfertig", 4 December 2020, https://www. sonnenhaus-institut.de/erstes-mehrfamilien-sonnenhaus-inregensburg-ist-bezugsfertig.html; Sonnenhaus Institut, "Ein Sonnensegel für das Mehrfamilien-Sonnenhaus", 4 December 2020, https://www.sonnenhaus-institut.de/ein-sonnensegel-fuerdas-mehrfamilien-sonnenhaus.html.
- 108 IEA, "Section updates heat pumps", https://www.iea.org/reports/ heat-pumps, viewed 4 October 2020.
- 109 REN21, op. cit. note 5, Chapter 6.
- 110 Heat output from J. W. Lund and A. N. Toth, "Direct utilization of geothermal energy 2020 worldwide review", Proceedings World Geothermal Congress 2020, Reykjavik, Iceland, 26 April - 2 May 2020, https://www.geothermal-energy.org/pdf/IGAstandard/ WGC/2020/01018.pdf.
- 111 CIBSE Journal, "Oxford's balancing act: city smart grid with ground source heat pumps", October 2020, https://www. cibsejournal.com/technical/oxfords-balancing-act-city-smartgrid-with-ground-source-heat-pumps.
- 112 Ibid.
- 113 D. Thorpe, "The town that saves millions on heating costs with a water source heat pump", Smart Cities Dive, https://www.smartcitiesdive.com/ex/sustainablecitiescollective/town-saves-millions-heating-costs-water-source-heat-pump/1055631, viewed 7 November 2020; Star Renewable Energy, "Star Renewable Energy provides Scotland's largest water source heat pump for district heating", 15 May 2019, http://www.neatpumps.com/news/star-renewable-energy-provides-scotland%E2%80%99s-largest-water-source-heat-pump-for-district-heating.aspx.
- 114 HeatSmart, "Commercial HeatSmart: Case studies", 2020, https://sustainablewestchester.org/wp-content/uploads/2020/05/Heatsmart-case-studies-2020.pdf.
- V. Spasić, "Decarbonisation is next step in development of district heating, cooling systems", Balkan Green Energy News, 6 December 2019, https://balkangreenenergynews.com/decarbonization-isnext-in-development-of-district-heating-cooling-systems.
- 116 IRENA, IEA and REN21, Renewable Energy Policies in a Time of Transition: Heating and Cooling (Paris: 2020), https://www. irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/ IRENA_IEA_REN21_Policies_Heating_Cooling_2020.pdf.
- 117 IEA, Renewables 2019: Market Analysis and Forecast from 2019 to 2024 (Paris: 2019), https://www.iea.org/reports/renewables-2019.
- 118 IEA, "How can district heating help decarbonize the heat sector by 2024?", 21 October 2019, https://www.iea.org/

- articles/how-can-district-heating-help-decarbonise-the-heat-sector-by-2024.
- 119 Ibid
- 120 Association of European Renewable Energy Research Centers, https://eurec.be, viewed 4 January 2020.
- 121 S. Werner, "International review of district heating and cooling", Energy, vol. 137 (15 October 2017), pp. 617-31, http://www. sciencedirect.com/science/article/pii/S036054421730614X.
- 122 IEA, World Energy Statistics and Balances, 2020 Edition (Paris: 2020), https://webstore.iea.org/ world-energy-balances-overview-2020-edition.
- 123 Euroheat & Power, "Country report Iceland", https://www.euroheat.org, viewed 30 September 2020; N. Calcea, "Europe makes progress integrating renewables in district heating", Energy Monitor, 16 September 2020, https://energymonitor.ai/sector/heating-cooling/europe-makes-progress-integrating-renewables-in-district-heating; Euroheat & Power, "District energy in Iceland", https://www.euroheat.org/knowledge-hub/district-energy-iceland, viewed 27 January 2021.
- 124 IEA, op. cit. note 122. Figure 13 based on data from idem.
- 125 Calcea, op. cit. note 123; World Bioenergy Association (WBA), Global Bioenergy Statistics 2019 (Brussels: 2019), https://worldbioenergy.org/ uploads/191129%20WBA%20GBS%202019_HQ.pdf.
- 126 WBA, op. cit. note 125.
- 127 Smart Together, "The largest biomass power plant in France: An exemplary partnership between the Métropole de Lyon, ADEME and Dalkia", 28 May 2019, https://www.smarter-together.eu/news/largest-biomass-power-plant-france-exemplary-partnership-between-metropole-de-lyon-ademe-and; Dalkia, "La chaufferie biomasse de Surville: un partenariat exemplaire entre la Métropole de Lyon, l'ADEME et Dalkia", https://www.dalkia.fr/fr/espace-presse/communique-de-presse/chaufferie-biomasse-surville, viewed 22 December 2020.
- 128 B. Epp, "15 MW SDH plant inaugurated in Latvia", solarthermalworld.org, 27 October 2019, https://www. solarthermalworld.org/news/15-mw-sdh-plant-inaugurated-latvia.
- 129 IEA Solar Heating & Cooling Programme, Solar Heat Worldwide 2020 (Paris: 2020), https://www.iea-shc.org/solar-heat-worldwide; Fortum, "District heating in Oslo", https://www.fortum.com/district-heating-oslo, viewed 27 January 2021.
- 130 REN21, op. cit. note 5.
- 131 IEA Solar Heating & Cooling Programme Task 55, Solar Heat for Cities: The Sustainable Solution for District Heating (Paris: 2019), https://task55.iea-shc.org/Data/Sites/1/publications/Solar-Heatfor-Cities--The-Sustainable-Solution-for-District-Heating.pdf.
- 132 IEA Solar Heating & Cooling Programme, "Germany country report", https://www.iea-shc.org/countries/germany/report, viewed 21 December 2020.
- 133 REN21, op. cit. note 5.
- 134 The cities are Samobor, Velika Gorica and Zaprešić, from B. Epp, "Three SDH plants under development in Croatia", solarthermalworld.org, 22 October 2020, https://www.solarthermalworld.org/news/ three-sdh-plants-under-development-croatia.
- 135 Heat capacity and output from Lund and Toth, op. cit. note 110.
- 136 Ibid
- City Snapshot: Malmö based on the following sources: Malmö stad, "Population", https://malmo.se/Fakta-och-statistik/Factsand-statistics-in-english/Population.html, viewed 5 January 2021; Swedish Environmental Protection Agency, National Inventory Report Sweden 2019 (Stockholm: 2019), https://www.naturvardsverket. se/upload/miljoarbete-i-samhallet/internationellt-miljoarbete/ miljokonventioner/FN/nir-sub-15-april.pdf; IRENA and ICLEI-Local Governments for Sustainability, Integrating Ambitious Renewable Energy Targets in City Planning (Abu Dhabi: 2013), https://www.irena. org/-/media/Files/IRENA/Agency/Publication/2013/Jan/IRENAcities-case-7-Malmo.pdf; European Commission, "European Green Capital Malmo Comments", https://ec.europa.eu/environment/ europeangreencapital/winning-cities/previous-finalists/malmo, viewed 5 January 2021; L. Guevara-Stone, "How Malmö, Sweden is leading way on sustainability", RenewEconomy, 24 September 2014, https://reneweconomy.com.au/malmo-sweden-leading-way-70597; J. Kamleh, Strategist, City of Malmö, presentation at Daring Cities 2020 event "100% Renewable Energy Roadmaps - Contributing to the Global Energy Transition", 13 October 2020; E.ON, "E.ON builds

- deep heat power plants in Sweden", 3 March 2020, https://www.eon.com/en/about-us/media/press-release/2020/2020-03-03-eon-builds-deep-heat-power-plants-in-sweden.html.
- 138 A. Richter, "City in Shaanxi Province, China launches innovative large-scale geothermal district heating system", Think GeoEnergy, 8 December 2019, https://www.thinkgeoenergy.com/city-in-shaanxi-province-china-launches-innovative-large-scale-geothermal-district-heating-system.
- 139 G. Dias, DTU, personal communication with REN21, 12 October 2020.
- 140 A. Richter, "SWM complete drilling campaign pushing forward with three week test run at heat plant in Munich", Think GeoEnergy, 15 March 2020, https://www.thinkgeoenergy.com/ swm-complete-drilling-campaign-pushing-forward-with-threeweek-test-run-at-heat-plant-in-munich.
- M. Kulmicht, "The geothermal heating network in Champs-sur-Marne launches", ENGIE, 30 October 2019, https://www.engiesolutions.com/en/news/geothermal-site-geomarne; GéoMarne, "Le réseau de chaleur GéoMarne, le futur réseau géothermique", 2 December 2019, http://geomarne.reseau-chaleur.com/le-reseaude-chaleur-geomarne-le-futur-reseau-geothermique; Lumo SAS, "Géothermie de Champs-sur-Marne et Noisiel", https://www.lumofrance.com/projets/geothermie-dela-marne, viewed March 2020.
- 142 La Ville de Drancy, "La géothermie à Drancy", https://www.drancy.fr/la-ville-s-engage-pour-lenvironnement/energies-renouvelables-drancy-s-engage-pour-un-avenir-vertueux-et-durable/la-geothermie-a-drancy-525.html, viewed March 2020; Sipperec, "Gényo: Un futur réseau de chaleur écologique pour BobignyDrancy", https://sipperec.fr/developper/produire-localementles-energies-de-demain/geothermie/genyo-un-futur-reseau-dechaleur-ecologique-pour-bobigny-drancy, viewed March 2020.
- 143 REN21, Renewables 2019 Global Status Report (Paris: 2019), https://www.ren21.net/wp-content/uploads/2019/05/ gsr_2019_full_report_en.pdf.
- 144 Wandschneider + gutjahr ingeniergesellschaft mbh, "Design of chillers HW2 (plant half 2) District Cooling City Nord", https://www.wg-ing.de/en/projects/district-cooling-city-nord-hamburg-fernkaelte-geschaeftsstadt-nord-gbr, viewed 10 January 2021; Sustainable Cities Vattenfall, "Berlin's biggest refrigerator", https://sustainablecities.vattenfall.com/en/berlin, viewed 10 January 2021; Bayut, "Chiller-free vs district cooling in Dubai", https://www.bayut.com/mybayut/chiller-free-district-cooling-dubai, viewed 21 December 2020; City of Toronto, "District energy", https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/district-energy, viewed 21 December 2020; IRENA, Renewable Energy in District Heating and Cooling: A Sector Roadmap for REmap (Abu Dhabi: 2017), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Mar/IRENA_REmap_DHC_Report_2017.pdf.
- 145 A. Richter, "Geothermal heat to also fuel district cooling network in Munich, Germany", Think GeoEnergy, 18 April 2020, https:// www.thinkgeoenergy.com/geothermal-heat-to-also-fuel-districtcooling-network-in-munich-germany.
- 146 Enwave, "Enware and Toronto Water tap into innovative energy source", https://www.enwave.com/case-studies/enwave-and-toronto-water-tap-into-innovative-energy-source, viewed 18 December 2020; ESEMAG, "Enwave to expand Toronto's deep lake water cooling system", 11 January 2019, https://esemag.com/water/expand-torontos-deep-lake-water-cooling-system.
- 147 This system makes use of the temperature difference of the river water, and can save up to 30% of energy compared with conventional air conditioning. From Z. Huan, "China's largest 'water air conditioning system' saves 30 percent energy", EN People, 13 July 2017, http://en.people.cn/n3/2017/0713/c90000-9241306.html.
- 148 IEA, "Renewable energy in transport 2018 and 2024", https://www.iea.org/data-and-statistics/charts/renewable-energy-intransport-2018-and-2024, updated 25 November 2019.
- 149 IEA, World Energy Outlook 2019 (Paris: 2019), https://www.iea. org/reports/world-energy-outlook-2019.
- 150 IRENA, op. cit. note 4; Agora Verkehrswende, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and World Economic Forum (WEF), Transport for Under Two Degrees – The Way Forward. 10 Key Insights for the Decarbonisation of the Transport Sector (Berlin: 2020), https://www.t4under2.org/pdf/ T4under2_Global-foresight-study_FINAL.pdf.
- 151 IEA, World Energy Outlook 2020 (Paris: 2020), https://www.iea.org/

- reports/world-energy-outlook-2020.
- 152 Campaign for Better Transport, Covid-19 Recovery: Renewing the Transport System (London: July 2020), https://bettertransport. org.uk/sites/default/files/research-files/Covid_19_Recovery_ Renewing_the_Transport_System.pdf.
- 153 IEA, The Covid-19 Crisis and Clean Energy Progress (Paris: 2020), https://www.iea.org/reports/the-covid-19-crisis-and-clean-energy-progress/transport.
- 154 J. Swira, "Creative destruction: The COVID-19 economic crisis is accelerating the demise of fossil fuels", African Mining Brief, 7 August 2020, https://africanminingbrief.com/creative-destruction-the-covid-19-economic-crisis-is-accelerating-the-demise-of-fossil-fuels; B. Chen, "E-bikes are having their moment. They deserve it", New York Times, 3 June 2020, https://www.nytimes.com/2020/06/03/technology/personaltech/e-bikes-are-having-their-moment-they-deserve-it.html; IEA, op. cit. note 151.
- 155 See REN21, op. cit. note 5.
- 156 IEA, Oil 2020 (Paris: 2020), https://www.iea.org/reports/oil-2020; IEA, Renewables 2019 (Paris: 2019), https://www.iea.org/reports/renewables-2019.
- For the location of US biodiesel and ethanol production facilities, see US National Renewable Energy Laboratory, "AFDC TransAtlas", https://maps.nrel.gov/transatlas/?aL=fbjBW9%255B v%255D%3Dt%26OgJeqs%255Bv%255D%3Dt%26OgJeqs%255Bd%255D%3D1&bL=clight&cE=0&lR=0&mC=39.45316112807 394%2C-98.06396484375&zL=5, viewed 15 December 2020.
- 158 According to IEA estimates, transport biofuel production was expected to contract 13% in 2020, its first drop in two decades. From IEA, op. cit. note 153.
- 159 Government of Mexico City, "Nueva planta productora de biodiésel en Central de Abasto", 4 August 2020, https://www. cdmx.gob.mx/portal/articulo/inaugura-gobierno-capitalino-eipn-planta-productora-de-biodiesel-en-central-de-abasto.
 - C40 Cities, "Case study: The circular economy in Venice: Green fuel for the city's boat fleet", 8 January 2020, https://www.c40. org/case_studies/the-circular-economy-in-venice-green-fuel-forthe-city-s-boat-fleet. Box 3 based on the following sources: The Explorer, "Moving public transport onto waterways", https://www. theexplorer.no/solutions/urban-water-shuttle--moving-publictransport-onto-waterways, viewed 29 October 2020; A. Matua, "City passes Queens councilman's bill to study how to power NYC ferries with renewable fuel", QNS, 2 January 2018, https://qns. com/2018/01/city-passes-queens-councilmans-bill-study-powernyc-ferries-renewable-fuel; A. Danigelis, "Copenhagen receives five zero-emissions ferries for public transport", Environment + Energy Leader, 7 July 2020, https://www.environmentalleader. com/2020/07/copenhagen-zero-emissions-ferries; ALT Energy Stocks, "Biofuels rocking the boats (and ships)", 24 July 2018, http://www.altenergystocks.com/archives/2018/07/ biofuels-rocking-the-boats-and-ships; S. Six, "Bunker biofuel pilot projects launch in Asia", Argus Media, 18 December 2020, https://www.argusmedia.com/en/news/2170286-bunker-biofuelpilot-projects-launch-in-asia; PR Newswire, "Red and White Fleet's long awaited plug-in vessel, 'The Enhydra', is available for use in San Francisco Bay", 13 September 2018, https://www. prnewswire.com/news-releases/red-and-white-fleets-longawaited-plug-in-vessel-the-enhydra-is-available-for-use-insan-francisco-bay-300711900.html; G. Han, "Hari Pontoon: The solar powered bamboo water taxi", Design Milk, 29 October 2020, https://design-milk.com/hari-pontoon-the-solar-poweredbamboo-water-taxi; 0Bills, "Solar panel powered water taxi plan for Cardiff to Bristol ferry", https://www.zerohomebills.com/ solar-panel-powered-water-taxi-plan-for-cardiff-to-bristol-ferry, viewed 29 October 2020; M. Meisenzahi, "A solar-powered boat will transport guests to an ultra-luxury resort in Bora Bora — see how it works", Business Insider, 13 June 2020, https://www. businessinsider.com/soel-yachts-soel-shuttle-14-solar-poweredluxury-water-taxi-2020-6; V. Varma, "India's first solar-powered ferry Aditya wins global honour", Indian Express, 27 July 2020, https://indianexpress.com/article/india/indias-first-solarpowered-ferry-aditya-wins-gustave-trouve-award-6525729; D. Bönnighausen, "Launch of the first e-car ferry Sankta Maria II", Electrive, 24 October 2017, https://www.electrive.net/2017/10/24/ stapellauf-der-ersten-e-autofaehre-sankta-maria-ii; M. Teliska, "Passenger ferries are going electric", AXIOS, 29 May 2019, https://www.axios.com/passenger-ferries-are-going-electriccb70b29f-fb19-4a10-bf53-24df0d9985bd.html; "Electric ferries

may become a major force on Bangkok's busy rivers". The Maritime Executive, 10 January 2020, https://www.maritimeexecutive.com/article/electric-ferries-may-become-a-majorforce-on-bangkok-s-busy-rivers; J. Butler, "Bangkok becoming electric ferry capital of the world", Plugboats, 24 August 2020, https://plugboats.com/bangkok-becoming-electric-ferrycapital-of-the-world; J. Butler, "Norway leads an electric ferry revolution", Plugboats, 27 January 2019, https://plugboats.com/ norway-leads-an-electric-ferry-revolution; World Maritime News, "Norled picks Westcon to build world's 1st hydrogen ferry", Offshore Energy, 29 May 2019, https://www.offshore-energy. biz/norled-picks-westcon-to-build-worlds-1st-hydrogen-ferry; E. Dudley, "Green-powered passenger ferries made by Brisbanebased small businesses", Dynamic Business, 16 November 2020, https://dynamicbusiness.com.au/topics/news/greenpowered-passenger-ferries-made-by-brisbane-based-smallbusinesses.html; DFDS, "Partnership aims to develop hydrogen ferry for Oslo-Copenhagen", press release (Copenhagen: 26 November 2020), https://www.dfds.com/en/about/media/news/ hydrogen-ferry-for-oslo-copenhagen.

- 161 R. Kotrba, "Eni opens its 2nd large-scale renewable diesel facility in Italy", Biodiesel Magazine, 26 September 2019, http://www.biodieselmagazine.com/articles/2516794/ eni-opens-its-2nd-large-scale-renewable-diesel-facility-in-italy.
- 162 "Neste, McDonald's Netherlands and HAVI promote circular economy", Petrol Plaza, 25 June 2020, https://www.petrolplaza. com/news/24993.
- 163 IEA, Outlook for Biogas and Biomethane: Prospects for Organic Growth (Paris: March 2020), https://www.iea.org/reports/outlookfor-biogas-and-biomethane-prospects-for-organic-growth/ an-introduction-to-biogas-and-biomethane.
- Ibid. In 2019, there were 89 total operational biomethane plants in the United States, producing 49 petajoules. Of these, more than 60% (54 confirmed operational plants) were producing biomethane for use as a vehicle fuel, with 30 more planned for this purpose. In the United States and Canada, in early 2020, there were 110 operational biomethane facilities transforming waste into fuel, 40 under construction and 58 in development. In Europe, the number of biomethane plants increased from 483 in 2018 to 729 in mid-2020, of which at least 19% were producing biomethane as vehicle fuel. See the following sources: M. Mintz and P. Voss, "Database of Renewable Natural Gas (RNG) Projects: 2019 Update", Argonne National Laboratory, October 2019, https://www.anl.gov/es/reference/ renewable-natural-gas-database; NGV America, Decarbonize Transportation with Renewable Natural Gas (Washington, DC: April 2020), https://www.ngvamerica.org/wp-content/uploads/2020/04/ NGV-RNG-Decarbonize-FINAL-April-2020.pdf; Gas Infrastructure Europe and European Biogas Association, European Biomethane Map: Infrastructure for Biomethane Production 2020 (Brussels: June 2020), https://www.gie.eu/maps_data/downloads/2020/ GIE_EBA_BIO_2020_A0_FULL_471.pdf.
- "CalBioGas produces first RNG with Kern County dairy farms", Bioenergy Insight, 28 September 2020, https://www.bioenergynews.com/news/calbiogas-produces-first-rng-with-kern-countydairy-farms.
- 166 A. Dimitrova, "The Hague opens its largest solar-power plant to date", The Mayor, 20 July 2020, https://www.themayor.eu/de/a/ view/the-hague-opens-its-largest-solar-power-plant-to-date-5409.
- 167 A. Dimitrova, "Poznan wants to power its buses with electricity from waste", The Mayor, 10 July 2020, https://www.themayor.eu/de/a/view/ poznan-wants-to-power-its-buses-with-electricity-from-waste-5350.
- 168 The waste material will be supplied by Inverhouse Distillery at Pulteney in Wick (Caithness County, Scotland), from "Whisky by-product could help power electric cars", BBC News, 2 July 2020, https://www.bbc.com/news/ uk-scotland-highlands-islands-53249366.
- 169 IRENA, Hydrogen: A Renewable Energy Perspective (Abu Dhabi: 2019), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Hydrogen_2019.pdf; IEA, "Hydrogen fuels & technologies", https://www.iea.org/fuels-and-technologies/hydrogen, viewed 20 September 2020; IEA, Hydrogen (Paris: June 2020), https://www.iea.org/reports/hydrogen; REN21, op. cit. note 5.
- 170 Toshiba, "The world's largest-class hydrogen production, Fukushima Hydrogen Energy Research Field (FH2R) now is completed at Namie town in Fukushima", press release (Tokyo: 7 March 2020), https:// www.toshiba-energy.com/en/info/info2020_0307.htm.
- 171 M. Mace, "Danish groups team up to deliver green hydrogen for

- transport fuel", Euractiv, 27 May 2020, https://www.euractiv.com/section/energy/news/danish-groups-team-up-to-deliver-green-hydrogen-for-transport-fuel.
- 172 FuelCellsWorks, "Development of the FuelCell Energy project at Toyota's Port of Long Beach facility to proceed", FuelCell Energy, 5 March 2020, https://fuelcellsworks.com/news/developmentof-the-fuelcell-energy-project-at-toyotas-port-of-long-beachfacility-to-proceed.
- 173 SEAFUEL plans to use renewable resources to demonstrate the feasibility of using hydrogen as fuel in isolated regions, promoting a sustainable transport system that can be adopted by other regions. Its innovative approach is based on the connection of filling stations to solar PV, wind and ocean energy installations, generating hydrogen depending on the availability of resources. From "Island of Tenerife plans to become a renewable hydrogen hub for mobility", NGV Journal, 5 August 2020, http://www.ngvjournal.com/s1-news/c7-lng-h2-blends/the-island-of-tenerife-plans-to-be-a-renewable-hydrogen-hub-for-transportation, and from SEAFUEL, "SEAFUEL project arouses interest from new associate partners in Tenerife", 29 July 2020, http://www.seafuel.eu/seafuel-project-arouses-interest-from-new-associate-partners-in-tenerife.
- 174 A final investment decision is expected in 2021, from E. Bellini, "Renewable-powered hydrogen for Oman", pv magazine, 5 March 2020, https://www.pv-magazine.com/2020/03/05/ renewable-powered-hydrogen-for-oman.
- 175 Calculations based on Organisation for Economic Co-operation and Development and International Transport Forum, ITF Transport Outlook 2019 (Paris: 2019), https://read.oecd-ilibrary.org/transport/ itf-transport-outlook-2019_transp_outlook-en-2019-en#page30.
- 176 IRENA, op. cit. note 11; REN21 and FIA Foundation, Renewable Energy Pathways in Road Transport (Paris: November 2020), https://www. fiafoundation.org/media/791530/renewable-energy-pathways.pdf.
- 177 D. Ainsley (Lewis Silkin), "Smart cities and renewable energy", Lexology, 14 May 2018, https://www.lexology.com/library/detail. aspx?g=1756875e-7331-468f-90a9-36657c875d44.
- 178 **Figure 14** from the following sources: IEA, *Global EV Outlook* 2020 (Paris: 2020), https://www.iea.org/reports/global-evoutlook-2020; REN21, op. cit. note 5; IEA, *Rail* (Paris: June 2020), https://www.iea.org/reports/rail; International Association of Public Transport (UITP), *Light Rail and Tram: The European Outlook* (Brussels: November 2019), https://cms.uitp.org/wp/wp-content/uploads/2020/09/Statistics-Brief-LRT-Europe2.pdf.
- 179 IEA, World Energy Statistics and Balances, 2019 Edition (Paris: 2019), https://webstore.iea.org/world-energy-statistics-and-balances-2019; IEA, Rail, op. cit. note 178.
- 180 IEA, Rail, op. cit. note 178.
- 181 Ibid.
- 182 Ibid.
- 183 REN21, op. cit. note 5.
- 184 "Chile's largest metro network to be powered by solar and wind", Climate Action, 21 June 2017, http://www.climateaction.org/news/ chiles-largest-metro-network-to-be-powered-by-solar-and-wind; TeleMedellín, "Metro de Medellín Trabajará Completamente con Energías Renovables en 2021", 30 December 2019, https:// telemedellin.tv/metro-de-medellin-trabajaria-completamentecon-energias-renovables-en-2021/370826; R. Meier, "Metrô de São Paulo estuda implantação de sistema próprio de geração de energia limpa", Metro CPTM, 23 July 2020, https://www. metrocptm.com.br/metro-de-sao-paulo-estuda-implantacaode-sistema-proprio-de-geracao-de-energia-limpa; Mayor of London, "Mayor moves forward with plans to power TfL Tube with green energy", 17 July 2020, https://www.london.gov.uk/pressreleases/mayoral/plans-to-power-tfl-network-with-green-energy; Seattle from M. Luczak, "Sound transit light rail running on 'clean energy", Railway Age, 2 December 2020, https://www.railwayage. com/passenger/light-rail/sound-transit-light-rail-running-onclean-energy; "'Greenest metro' in Nagpur sets new standards", New Indian Express, 11 June 2019, https://www.newindianexpress. com/nation/2019/iun/11/greenest-metro-in-nagpur-sets-newstandards-1988521.html; Delhi from P. V. Lal, "750 MW Rewa solar project starts supplying power", pv magazine, 9 July 2018, https://www.pv-magazine-india.com/2018/07/09/750-mw-rewasolar-project-starts-supplying-power; Utrecht from A. Dimitrova, "The Hague opens its largest solar-power plant to date", The Mayor, 20 July 2020, https://www.themayor.eu/de/a/view/ the-hague-opens-its-largest-solar-power-plant-to-date-5409.

- 185 Agence France-Presse, "Germany launches world's first hydrogen-powered train", The Guardian (UK), 11 September 2018, https://www.theguardian.com/environment/2018/ sep/17/germany-launches-worlds-first-hydrogen-poweredtrain; "Hydrogen train tests in the Netherlands successfully meets objectives", Global Railway Review, 30 September 2020, https://www.globalrailwayreview.com/news/110138/ hydrogen-train-tests-netherlands-successful.
- "18 new biodiesel fueled trains coming to the Netherlands", Biofuels International, 13 July 2017, https://biofuels-news.com/ news/18-new-biodiesel-fuelled-trains-coming-to-the-netherlands.
- 187 B. Nielsen, "Next generation clean local transport Birmingham City University's IDEA think tank a lead partner in developing the UK's first biomethane-powered tram", Centre for Brexit Studies Blog, 24 July 2020, https://centreforbrexitstudiesblog. wordpress.com/2020/07/24/next-generation-clean-local-transport-birmingham-city-universitys-idea-think-tank-a-lead-partner-in-developing-the-uks-first-biomethane-powered-tram; J. Corser, "Railcars powered by manure on their way", Express & Star, 2 January 2021, https://www.expressandstar.com/news/environment/2021/01/02/railcars-powered-by-manure-on-their-way.
- 188 J-P. Rodrigue, "Urban transport challenges", in *The Geography of Transport Systems* (New York: Routledge, 2017), https://transportgeography.org/?page_id=4621; Agora Verkehrswende, GIZ and WEF, op. cit. note 150; World Bank, "Urban Transport Data Analysis Tool (UT-DAT)", https://www.worldbank.org/en/topic/transport/publication/urban-transport-data-analysis-tool-ut-dat1, viewed 29 October 2020.
- "How electric buses are hailing the future of city transport", Bloomberg, 2 November 2020, https://sponsored.bloomberg. com/news/sponsors/features/enel-x/discover-enel-xs-plan-forcleaner-city-transport/?adv=31683&prx_t=bzkGAgClIAXykPA.
- 190 UITP, Global Bus Survey (Brussels: 2019), https://cms.uitp.org/ wp/wp-content/uploads/2020/07/Statistics-Brief_Global-bussurvey-003.pdf.
- 191 Shanghai (China) produces over 30,000 metric tonnes per year of discarded cooking oil that is locally refined to make B5 and sold at 247 gas stations in the city, from H. Jing, "Over 2,000 Shanghai buses to run on biodiesel made from gutter oil", Shine, 7 May 2019, https://www.shine.cn/news/metro/1905074258; "Norwegian city rolls out biogas, biodiesel buses to reduce carbon footprint", Biofuels International, 11 September 2019, https://biofuels-news.com/news/norwegian-city-rolls-out-biogas-biodiesel-buses-to-reduce-carbon-footprint.
- 192 "64 buses in Tartu, Estonia to run on biomethane", Bioenergy Insight, 16 January 2020, https://www.bioenergy-news.com/ news/64-buses-in-tartu-estonia-to-run-on-biomethane.
- 193 Columbia from Central Midlands Regional Transit Authority, "The Comet now uses biodiesel in its 39 diesel buses", Mass Transit, 5 August 2019, https://www.masstransitmag.com/bus/vehicles/gas-diesel-cng-lng/press-release/21091398/central-midlands-regional-transit-authority-cmrta-the-comet-the-comet-now-uses-biodiesel-in-its-39-diesel-buses; North Dakota Soybean Council, "City buses in Grand Forks, North Dakota, running on B20 biodiesel", Biodiesel Magazine, 16 July 2020, http://biodieselmagazine.com/articles/2517082/city-buses-in-grand-forks-north-dakota-running-on-b20-biodiesel.
- 194 REN21, op. cit. note 5; IEA, Global EV Outlook 2020, op. cit. note 178; IEA, "New electric bus registrations in China, 2015-2019", 14 June 2020, https://www.iea.org/data-and-statistics/charts/ new-electric-bus-registrations-in-china-2015-2019; IEA, "New electric bus registrations by country/region, 2015-2019", 14 June 2020, https://www.iea.org/data-and-statistics/charts/ new-electric-bus-registrations-by-country-region-2015-2019; BloombergNEF, Electric Buses in Cities: Driving Towards Cleaner Air and Lower CO2 (London: March 2018), https://assets.bbhub.io/professional/sites/24/2018/05/Electric-Buses-in-Cities-Report-BNEF-C40-Citi.pdf. Figure 15 based on data from IEA, Global EV Outlook 2020, op. cit. note 178, as reported in REN21, op. cit. note 5, and updated based on IEA, "New electric bus registrations by country/region, 2015-2019", op. cit. this note, and on IEA, "New electric bus registrations in China, 2015-2019", op. cit. this note.
- 195 IEA, "New electric bus registrations by country/region, 2015-2019", op. cit. note 194; IEA, "New electric bus registrations in China, 2015-2019", op. cit. note 194. In 2019, the Polish bus manufacturer Solaris Europa claimed to have concluded the most contracts for the construction of electric buses. Some 800 electric-powered Solaris buses are now

- circulating in 72 cities, including Berlin (90 buses), Milan (250) and Warsaw (130); 47% of the buses built by Solaris are powered by an alternative propulsion system. Worldwide, more than 120,000 Yutong electric buses are operating in more than 380 cities, resulting in a global market share of 15% for Yutong. For nine consecutive years, Yutong was the largest seller of new energy buses. From Busworld, "Increasingly more electric buses", 19 October 2019, https://www.busworld.org/articles/detail/4813/increasingly-more-electric-buses.
- 196 R. Whitlock, "Forsee Power to equip electric buses in the city of London", Renewable Energy Magazine, 26 July 2019, https://www.renewableenergymagazine.com/electric_hybrid_vehicles/forsee-power-to-equip-electric-buses-in-20190726; Mayor of London, "London's electric bus fleet becomes the largest in Europe", 5 September 2019, https://www.london.gov.uk/press-releases/mayoral/london-has-europes-largest-electric-bus-fleet; P. Dzikiy, "Milan to receive 250 electric buses from Solaris in one of Europe's largest e-bus orders yet", Electrek, 10 July 2019, https://electrek.co/2019/07/10/milan-250-electric-buses-solaris; C. Randall, "Daimler delivers 16 electric buses to Hamburg", Electrive, 27 January 2020, https://www.electrive.com/2020/01/27/daimler-delivers-16-electric-buses-to-hamburg.
- 197 IRIS Smart Cities, "55 new electric busses in Utrecht", 25 April 2019, https://irissmartcities.eu/content/55-new-electricbusses-utrecht; "First of 130 Solaris electric buses deployed in Warsaw", Green Car Congress, 28 March 2020, https://www. greencarcongress.com/2020/03/20200328-solaris.html.
- E. Chung, A. Hopton and T. Reid, "What cities can learn from the biggest battery-powered electric bus fleet in North America", CBC, 2 December 2020, https://www.cbc.ca/news/technology/electricbuses-transit-1.5823166; US PIRG Education Fund, Electric Buses in America: Lessons from Cities Pioneering Clean Transportation (Denver, CO: October 2019), https://uspirg.org/sites/pirg/files/ reports/ElectricBusesInAmerica/US_Electric_bus_scrn.pdf; P. Dzikiy, "Portland's new electric buses run on wind energy, a first in US transit", Electrek, 22 April 2019, https://electrek.co/2019/04/22/ portland-electric-buses-wind; K. Tigue, "U.S. electric bus demand outpaces production as cities add to their fleets", Inside Climate News, 14 November 2019, https://insideclimatenews.org/ news/14112019/electric-bus-cost-savings-health-fuel-charging; D. Lefler, "Wichita, Kan., is state's first city to use electric buses", GT, 13 December 2019, https://www.govtech.com/transportation/ Wichita-Kan-is-States-First-City-to-Use-Electric-Buses.html; J. Sensiba, "Wyoming gets its first electric bus", CleanTechnica, 29 November 2020, https://cleantechnica.com/2020/11/29/wyominggets-its-first-electric-bus; L. Belmonte, "Electric buses are coming to this GTA city and the government's hoping it's a game changer", Narcity, 19 July 2019, https://www.narcity.com/en-ca/news/toronto/ brampton-electric-buses-aim-to-accelerate-plans-for-greener-canada.
- 199 City of São Paulo, "São Paulo passa a ter a maior frota de ônibus 100 % elétricos do país", November 2019, http://www.capital. sp.gov.br/noticia/sao-paulo-passa-a-ter-a-maior-frota-de-onibus-100-eletricos-do-pais; Mayor of Bogotá, "Primer bus eléctrico del SITP ya se encuentra en Bogotá", December 2019, https://bogota.gov.co/mi-ciudad/movilidad/transmilenio/buses-electricos-del-sitp-en-bogota; Transmilenio S.A., "Estadísticas de oferta y demanda del Sistema Integrado de Transporte Público SITP Febrero 2020", April 2020, https://www.transmilenio.gov.co/publicaciones/151672/estadisticas-de-oferta-y-demanda-del-sistema-integrado-de-transporte-publico-sitp-febrero-2020/.
- 200 This includes 563 standard e-buses, 624 trolley buses, 41 midi e-buses and 1 articulated e-bus, from E-bus Radar, https://www.ebusradar.org, viewed 23 September 2020.
- 201 IEA, Global EV Outlook 2020, op. cit. note 178; E-bus Radar, op. cit. note 200.
- 202 Based on SLOCAT Partnership on Sustainable Transport, Transport and Climate Change Global Status Report (TCC-GSR) Policy Database; A. Parikh, "Delhi to shut Raighat thermal power project, use land for 5 MW solar park", Mercom India, 15 July 2019, https://mercomindia.com/delhi-raighat-thermal-projectsolar-park; R. Nair, "Pune announces tender for 150 electric buses under FAME-II Program", Mercom India, 15 September 2020, https://mercomindia.com/pune-tender-electric-buses.
- 203 Sustainable Energy for All, Switching Gears: Enabling Access to Sustainable Urban Mobility (Washington, DC: February 2020), https://www.seforall.org/system/files/2020-02/SEforALL-Switching_Gears.pdf; S. Meniano, "Modernization transforms Tacloban's commuting experience", Philippine News Agency, 17 July 2019, https://www.pna.gov.ph/articles/1075086.

- 204 J. M. Takouleu, "Egypt: Government launches first electric bus service", Afrik21, 14 November 2019, https://www.afrik21.africa/ en/egypt-government-launches-first-electric-bus-service; "Mwasalat Misr announces launching X-Bus", Egypt Today, 5 February 2020, https://www.egypttoday.com/Article/1/81306/ Mwasalat-Misr-announces-launching-X-Bus.
- 205 "Volvo receives order for electric, biodiesel buses in Swedish city", Biofuels International, 6 November 2019, https://biofuels-news. com/news/volvo-receives-order-for-electric-biodiesel-buses-in-swedish-city; Groupe RATP, "RATP Group 2018 results: A year of profitable growth and investments to the benefit of passengers", press release (Paris: 29 March 2019), https://www.ratpdev.com/sites/default/files/annexes/communiques/RATP%20Group%20 2018%20results.pdf.
- 206 IEA, Global EV Outlook 2020, op. cit. note 178; M. Burgess, "1,000 new hydrogen-powered buses planned for European roads", H2-View, 17 September 2020, https://www.h2-view. com/story/1000-new-hydrogen-powered-buses-planned-foreuropean-roads; Fuel Cells and Hydrogen Joint Undertaking, Fuel Cells and Hydrogen for Green Energy in European Cities and Regions (Brussels: May 2018), https://www.fch.europa. eu/sites/default/files/180515 FCH2JU BCs%20Regions%20 Cities_Stakeholder%20Communication%20Package_English_ OUT%20%28ID%203520090%29.pdf; Fuel Cell Electric Buses, "Demos in Europe: Bus locations", https://www.fuelcellbuses. eu/category/demos-europe, viewed 23 September 2020; T. Kawakami, "'Hydrogen Valley' powers China's fuel cell industry", Nikkei Asia, 4 July 2020, https://asia.nikkei.com/Business/ China-tech/Hydrogen-Valley-powers-China-s-fuel-cell-industry; "Zhangjiakou is speeding up to build a 'Hydrogen Energy City', the advantages of renewable energy hydrogen production are highlighted", Netease News, 15 June 2020, https://3g.163.com/dy/ article/FF6AA8750534CY9P.html (using Google Translate).
- 207 G. Zhang, J. Zhang and T. Xie, "A solution to renewable hydrogen economy for fuel cell buses a case study of Zhangjiakou in North China", International Journal of Hydrogen Energy, vol. 45, no. 29 (2020), pp. 14603-13, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173837; S. Lewis, "N China hydrogen push led by hydrogen as by-product, renewables", S&P Global Platts, 11 June 2020, https://www.spglobal.com/platts/en/market-insights/latest-news/metals/061120-n-china-hydrogen-push-led-by-hydrogen-as-by-product-renewables.
- 208 R. Whitlock, "The world's first hydrogen-powered double decker bus arrives in Aberdeen", Renewable Energy Magazine, 9 October 2020, https://www. renewableenergymagazine.com/miscellaneous/ the-worlda-s-first-hydrogenpowered-double-decker-20201009.
- 209 S. Gössling, "Why cities need to take road space from cars and how this could be done", *Journal of Urban Design*, vol. 25, no.4 (2020), pp. 443-48, https://www.tandfonline.com/doi/full/10.1080 /13574809.2020.1727318.
- 210 Sales of electric cars topped 2.1 million globally in 2019, surpassing 2018 already a record year. China remains the world's largest market for electric cars, followed by Europe and the United States. Battery electric cars (comprising battery electric cars and plug-in hybrid electric cars) made up a larger portion of electric car sales (almost three-quarters) in 2019. From IEA, Global EV Outlook 2020, op. cit. note 178.
- 211 IEA, Global EV Outlook 2020, op. cit. note 178.
- 212 H. Cui, D. Hall and N. Lutsey, Update on the Global Transition to Electric Vehicles Through 2019 (Washington, DC: International Council on Clean Transportation (ICCT), July 2020), https:// theicct.org/sites/default/files/publications/update-global-EVstats-20200713-EN.pdf.
- 213 N. Kampouris, "Greece's Trikala to offer electric vehicles for public use inside the city", Greek Reporter, 17 April 2019, https://greece.greekreporter.com/2019/04/17/greeces-trikala-to-offer-electric-vehicles-for-public-use-inside-the-city; Bristol City Council, "New electric vehicle fleet for hire in Bristol following funding boost", 29 May 2019, https://news.bristol.gov.uk/news/new-electric-vehicle-fleet-for-hire-in-bristol-following-funding-boost; BlueLA, https://www.bluela.com, viewed 20 September 2020.
- 214 MOVMI, "Carsharing market & growth analysis 2019", 10 July 2019, https://movmi.net/carsharing-market-growth-2019; H. Lardier, "Video: In Utrecht, carsharing is being powered by solar energy", Groupe Renault #easyelectriclife, 14 August 2019, https://easyelectriclife.groupe.renault.com/en/day-to-day/

- shared-mobility/video-in-utrecht-carsharing-is-being-powered-by-solar-energy; R. Whitlock, "Volkswagen WeShare launched in Berlin as full-electric service", Renewable Energy Magazine, 28 June 2019, https://www.renewableenergymagazine.com/electric_hybrid_vehicles/volkswagen-weshare-launched-in-berlin-as-fullelectric-20190628; REN21, op. cit. note 5.
- 215 A. Ingram, "BYD e6 electric taxi fleet launched in Hong Kong to cut pollution", Green Car Reports, 23 March 2013, https:// www.greencarreports.com/news/1084356_byd-e6-electrictaxi-fleet-launched-in-hong-kong-to-cut-pollution; J. Ayre, "Macao gets its first electric taxi fleet thanks to partnership with BYD", CleanTechnica, 18 February 2018, https://cleantechnica. com/2018/02/13/macao-gets-first-electric-taxi-fleet-thankspartnership-byd; "Giving up gas: China's Shenzhen switches to electric taxis", Phys.org, 8 January 2019, https://phys.org/ news/2019-01-gas-china-shenzhen-electric-taxis.html; LEVC, "London's largest electric taxi fleet expands to over 70 new TX taxis", 21 September 2018, https://www.levc.com/corporate/ news/largest-taxi-fleet-expands; B. Schmidt, "Thousands of electric taxis in London have saved 6800 tonnes of CO2", The Driven, 2 August 2019, https://thedriven.io/2019/08/02/ thousands-of-electric-taxis-in-london-have-saved-6-8-tonnesof-co2; A. Hirschfeld, "Taxis go electric: Tesla joins cab fleets in New York City", Observer, 15 November 2019, https://observer. com/2019/11/tesla-taxi-electric-vehicles-cab-fleets; F. Lambert, "A fleet of Tesla cars are being deployed as taxis in Columbus", Electrek, 2 August 2019, https://electrek.co/2019/08/02/teslafleet-taxi-columbus; EkoRent, "Landmark development as first full electric mobility company launches in Nairobi", 9 August 2018, https://ekorent.fi/en/news-en/landmark-development-asfirst-full-electric-mobility-company-launches-in-nairobi; UITP, Global Taxi Benchmarking Study 2019 (Brussels: November 2020), https://cms.uitp.org/wp/wp-content/uploads/2020/11/Statistics-Brief-TAxi-Benchmarking_NOV2020-web.pdf.
- 216 ETAuto, "India offers its unused electric vehicles to taxi fleets", 1 August 2019, https://auto. economictimes.indiatimes.com/news/aftermarket/ india-offers-its-unused-electric-vehicles-to-taxi-fleets/70478371.
- 217 The Moving Rwanda Initiative provides for the collection and analysis of data on aspects such as the performance of electric cars, consumer acceptance, consumption trends and appropriate traffic conditions, maintenance and above all charging for cars. To improve the reliability of data collected during the pilot phase, an increase in the operational capacity is planned. The number of cars was expected to increase from 4 to around 50, while the number of charging stations across the city should increase from 1 to 15. From B. Ngounou, "Rwanda: Volkswagen launches electric car pilot project in Kigali", Afrik21, 31 October 2019, https://www.afrik21.africa/en/rwanda-volkswagen-launches-electric-car-pilot-project-in-kigali.
- 218 Driving, "Téo Taxi returns to Quebec streets afer withdrawing from the province in 2019", 31 October 2020, https://driving.ca/ kia/auto-news/news/teo-taxi-returns-to-quebec-streets-afterwithdrawing-from-the-province-in-2019.
- 219 Practically all of the fuel cell EVs (FCEVs) in the United States, Japan and the Republic of Korea are passenger cars. Similarly, the European FCEV stock is dominated by cars (almost 95%), although in this case, there are also a few buses (80 units) and trucks (28 light-commercial vehicles and 8 heavy-duty trucks). From IEA, Global EV Outlook 2020, op. cit. note 178.
- 220 California Air Resources Board, 2020 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development (Sacramento, CA: September 2020), p. 14, https://www2.arb.ca.gov/sites/default/files/2020-09/ab8_report_2020.pdf; J. Cart, "California's 'hydrogen highway' never happened. Could 2020 change that?", Cal Matters, 9 January 2020, https://calmatters.org/environment/2020/01/why-california-hydrogen-cars-2020; European Commission, "Hydrogen drives Europe towards emissions-free transport", 29 August 2016. https://ec.europa.eu/programmes/horizon2020/en/news/hydrogen-drives-europe-towards-emissions-free-transport.
- 221 FuelCellsWorks, "Taking a taxi in Paris: Now with hydrogen!" 29 March 2019, https://fuelcellsworks.com/news/taking-a-taxi-in-paris-now-with-hydrogen. More recent plans mention the possibility to convert 50,000 taxis or "taxi-like vehicles" to FCEVs running on "green" and "blue" hydrogen in the French capital. From M. Hall, "Plans for 50,000 hydrogen-powered taxis in Paris", pv magazine, 12 November 2020, https://www.

- pv-magazine.com/2020/11/12/plans-for-50000-hydrogen-powered-taxis-in-paris; State of Green, "Hail a hydrogen-powered taxi on the streets of Copenhagen", 14 May 2019, https://stateofgreen.com/en/partners/state-of-green/news/hail-a-hydrogen-powered-taxi-on-the-streets-of-copenhagen.
- 222 IEA, Global EV Outlook 2020, op. cit. note 178; IEA, Global EV Outlook 2019 (Paris: 2019), https://www.iea.org/publications/reports/globalevoutlook2019.
- 223 In 2019, the stock of electric two-wheelers in China was close to 300 million units and the stock of three-wheelers was around 50 million units. India is home to around 1.5 million battery-powered electric three-wheelers/e-rickshaws and 0.6 million electric twowheelers. From IEA, Global EV Outlook 2020, op. cit. note 178; New Urban Mobility Alliance, "New Mobility Atlas", https://www.numo. global/new-mobility-atlas#2/20.7/-0.48, viewed 30 March 2020.
- 224 R. Halder, "Solar rickshaws make debut on IIT-Delhi campus", Times of India, 20 July 2019, https://timesofindia.indiatimes. com/city/delhi/solar-rickshaws-make-debut-on-iit-d-campus/articleshow/70299940.cms.
- 225 "Uganda's motorbikes go green", DW, 12 May 2020, https://www.dw.com/en/ugandasmotorbikes-go-green/a-53359578; "A sunny future for e-bikes in Namibia", DW, 22 March 2019, https://www.dw.com/en/a-sunny-future-for-e-bikes-in-namibia/av-48013690.
- 226 C. Lewis, "Logistics hotspots: Nine that shine", Inbound Logistics, 20 September 2016, https://www.inboundlogistics.com/cms/article/logistics-hotspots-nine-that-shine.
- 227 IEA, Global EV Outlook 2020, op. cit. note 178.
- 228 Ibid.
- 229 B. Schmidt, "Sendle rolls out solar-powered electric delivery vehicles in Australia", The Driven, 9 June 2020, https://thedriven.io/2020/06/09/sendle-rolls-out-solar-powered-electric-delivery-vehicles-in-australia.
- 230 R. Cooper, "Royal Mail trials electric taxi van for parcel and letter deliveries", Climate Action, 9 July 2020, http://www. climateaction.org/news/royal-mail-trials-electric-taxi-van-forparcel-and-letter-deliveries; J. Barrie, "John Lewis and Waitrose will start rolling out a new electric van delivery fleet next year", iNews, 29 July 2020, https://inews.co.uk/news/environment/ john-lewis-waitrose-new-electric-van-delivery-fleet-2021-564927.
- 231 Transport Decarbonisation Alliance, Zero Emission Urban Freight (May 2019), http://tda-mobility.org/wp-content/uploads/2019/05/ TDA-Zero-Emission-Urban-Freight.pdf.
- 232 A. Zaleski, "Cities seek deliverance from the e-commerce boom", Bloomberg CityLab, 20 April 2017, https://www.bloomberg.com/news/articles/2017-04-20/how-cities-are-coping-with-the-delivery-truck-boom; CIVITAS, Smart Choices for Cities: Making Urban Freight Logistics More Sustainable (no date), https://civitas.eu/sites/default/files/civ_pol-an5_urban_web.pdf.
- 233 nFront Consulting LLC, Orlando Utilities Commission 2019 Ten-Year Site Plan (Orlando, FL: April 2019), http://www.psc.state.fl.us/Files/PDF/Utilities/Electricgas/TenYearSitePlans/2019/Orlando%20 Utilities%20Commission.pdf; "Shell partners with Maxim's Group, turning waste into energy to power commercial fleets", Markets Insider, 11 March 2019, https://markets.businessinsider.com/news/stocks/shell-partners-with-maxim-s-group-turning-waste-into-energy-to-power-commercial-fleets-1028017961.
- 234 C. Sølvsten, "22 nye skraldebiler i Esbjerg kører på biogas fra affald og gylle", TVS, 21 September 2020, https://www.tvsyd.dk/ esbjerg/22-nye-skraldebiler-i-esbjerg-koerer-paa-biogas-fraaffald-og-gylle (using Google Translate); "Neste, McDonald's Netherlands and HAVI promote circular economy", op. cit. note 162.
- 235 "Garbage collection trucks market benefits from steady sales of refuse trucks", Recycling Magazine, 24 September 2019, https:// www.recycling-magazine.com/2019/09/24/garbage-collectiontrucks-market-benefits-from-steady-sales-of-refuse-trucks. See also information and sources used throughout this section.
- 236 The official data submitted for sales of medium- and heavy-duty (with greater than 3.5 tonnes gross vehicle weight) electric trucks in China report 6,112 vehicles in 2019, 60% more than the previous sales spike in 2017. From IEA, *Trucks and Buses* (Paris: 2020), https://www.iea.org/reports/trucks-and-buses.
- 237 K. Field, "BYD lands deal for 500 electric refuse trucks with two companies in Shenzhen", CleanTechnica, 16 May 2018, https://cleantechnica.com/2018/05/16/byd-lands-deal-for-500-electric-refuse-trucks-with-two-companies-in-shenzhen.

- 238 J. Gitlin, "Seattle makes history with electric garbage truck", ARS Technica, 22 May 2019, https://arstechnica.com/cars/2019/05/ seattle-makes-history-with-electric-garbage-truck.
- 239 M. Bloch, "SA's first electric garbage truck doing the rounds", Sea Electric, 25 February 2020, https://www.sea-electric.com/sas-first-electric-garbage-truck-doing-the-rounds; B. Schmidt, "Australia's first fully electric rubbish trucks clean up in Casey", The Driven, 24 May 2019, https://thedriven.io/2019/05/24/australias-first-fully-electric-rubbish-trucks-clean-up-in-casey.
- 240 IEA, Global EV Outlook 2020, op. cit. note 178.
- 241 R. Cooper, "'World first' full-electric delivery vehicle to be trailled in London", Climate Action, 4 August 2020, http://www.climateaction.org/ news/world-first-full-electric-delivery-vehicle-to-be-trialled-in-london.
- 242 A. Stoyanov, "Manchester waste collection goes eco-friendly", The Mayor, 7 June 2020, https://www.themayor.eu/en/a/view/manchester-waste-collection-goes-eco-friendly-5124.
- 243 City Logistics, "European demonstration programme on hydrogen garbage trucks: LIKE 'N Garb HY!", 13 August 2020, http://www. citylogistics.info/projects/european-demonstration-programmeon-hydrogen-garbage-trucks-life-n-garb-hy; Interreg North-West Europe HECTOR, "Project summary", 4 October 2019, https://www. nweurope.eu/projects/project-search/hector-hydrogen-wastecollection-vehicles-in-north-west-europe.
- 244 N. B. Groth, C. Fertner and J. Grosse, "Urban energy generation and the role of cities", *Journal of Settlements and Spatial Planning*, Special Issue no. 5 (2016), pp. 5-17, https://geografie.ubbcluj.ro/ ccau/jssp/arhiva_si5_2016/02JSSPSI052016.pdf.
- 245 See, for example, K. Appunn, "Energiewende hinges on unblocking the power grid", Clean Energy Wire, 10 April 2018, https://www.cleanenergywire.org/dossiers/energy-transitionand-germanys-power-grid.
- 246 See, for example, K. A. Alboaouh and S. Mohagheghi, "Impact of rooftop photovoltaics on the distribution system", Journal of Renewable Energy (2020), pp. 1-23, https://doi. org/10.1155/2020/4831434.
- 247 K. Cleary and K. Palmer, "Renewables 101: Integrating renewable energy resources into the grid", Resources for the Future, 15 April 2020, https://www.rff.org/publications/explainers/renewables-101-integrating-renewables.
- 248 City Snapshot: Oxford based on the following sources: Oxford City Council, Climate Emergency Strategy Support Report September 2019 (Oxford: 2020), https://www.oxford.gov.uk/downloads/file/6660/climate_emergency_strategy_support_report_2019; Edie, "Oxford City Council targets net-zero by end of 2020", 16 December 2019, https://www.edie.net/news/9/Oxford-City-Council-targets-net-zero-by-end-of-2020; Oxford City Council, "£41m project to support Oxford on journey to zero carbon", 3 April 2019, https://www.oxford.gov.uk/news/article/1049/41m_project_to_support_oxford_on_journey_to_zero_carbon.
- 249 REN21, op. cit. note 5.
- 250 T. Stevens, "At least 24 Utah cities, counties pledge to use renewable energy by 2030", Salt Lake Tribune, 13 January 2020, https://www.sltrib.com/news/politics/2020/01/13/least-utah-cities.
- 251 Salt Lake City, "100% Renewable Energy Community Goal", https://www.slc.gov/sustainability/100-renewable-energy-community-goal, viewed 15 December 2020; "Utah communities celebrate landmark renewable energy legislation", slcgreen, 23 April 2019, https://slcgreenblog.com/2019/04/23/community-renewable-energy-act.
- 252 Los Angeles Department of Water and Power (LADWP), "Green hydrogen & the Intermountain Power Project", presentation, https://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/ Utilities_and_Industries/Energy/Energy_Programs/Gas/Natural_ Gas_Market/Nov13LADWP.pdf, viewed September 2020.
- 253 Ibid
- 254 N. S. Malik, "L.A. aims to be the first to power U.S. city with renewable hydrogen", Bloomberg, 10 March 2020, https://www.bloomberg.com/news/articles/2020-03-10/l-a-aims-to-be-first-to-power-u-s-city-with-renewable-hydrogen.
- 255 LADWP, op. cit. note 252; Malik, op. cit. note 254.
- 256 Malik, op. cit. note 254.
- 257 City of Sydney, "5 things to know about our electricity deal", https://news.cityofsydney.nsw.gov.au/articles/5-things-to-know-about-our-electricity-deal, viewed 15 December 2020.
- 258 Ibid.

- 259 S. Hanley, "City of Sydney goes 100% renewable", CleanTechnica, 3 July 2020, https://cleantechnica.com/2020/07/03/city-of-sydney-goes-100-renewable.
- 260 E. Chidley, "London pioneers the city's first 'virtual power station'", Climate Action, 10 March 2020, http://www.climateaction.org/news/london-pioneers-the-citys-first-virtual-power-station.
- 261 Energy Sector Management Assistance Program (ESMAP), Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers (Washington, DC: World Bank, June 2019), https://esmap.org/mini_grids_for_half_a_billion_people; IRENA, Innovation Landscape Brief: Renewable Mini-Grids (Abu Dhabi: 2019), https://www.irena.org/-/media/Files/IRENA/ Agency/Publication/2019/Sep/IRENA_Renewable_mini-grids_2019.pdf.
- 262 EMSD Energy Land, "Building DCS in other countries", https://www.emsd.gov.hk/energyland/en/building/district_cooling_sys/dcs_countries.html, viewed 15 December 2020.
- 263 Building Energy Conservation Research Center and IEA, District Energy Systems in China: Options for Optimization and Diversification (Paris: 2017), https://www.researchgate.net/ publication/335978479_District_Energy_Systems_in_china_ options_for_Optimization_and_Diversification.
- 264 Euroheat & Power, "Country by country 2019", https://www. euroheat.org/cbc_publications/cbc2019/sweden, viewed 22 December 2020.
- 265 State of Green, "Supplying cities with energy through collective heating and cooling", https://stateofgreen.com/en/creatingsmart-green-liveable-cities/heating-and-cooling-the-city, viewed 3 January 2020.
- 266 West Dunbartonshire Council, "Pioneering district heating network now heating Clydebank", 9 December 2020, https://www.west-dunbarton.gov.uk/council/newsroom/news/2020/dec/district-heating-network; R. Dixon, "Scotland is about to hit its 100% renewable electricity target. It must go further", The Scotsman, 25 May 2020, https://www.scotsman.com/news/opinion/columnists/scotland-about-hit-its-100-renewable-electricity-target-it-must-go-further-richard-dixon-2864016.
- 267 D. Mavrokefalidis, "Leeds injects £24m to develop six new district heating networks", Energy Live News, 12 October 2020, https://www.energylivenews.com/2020/10/12/leeds-injects-24m-to-develop-six-new-district-heating-networks.
- 268 DHC News, "Mountauban: Installation des canalisations du réseau de chaleur", 2 December 2020, https://www.dhcnews. com/montauban-installation-canalisations-reseau-chaleur.
- 269 HOFOR, "District cooling reduces CO2 emissions in central Copenhagen", State of Green, https://stateofgreen.com/en/partners/hofor-utility-company/solutions/district-cooling-reduces-co2-emissions-in-central-copenhagen, viewed 22 December 2020; DBDH, "District cooling", http://www.e-pages.dk/dbdh/77, viewed 22 December 2020; Smart City Sweden, "Gothenburg smart district cooling", https://smartcitysweden.com/best-practice/386/gothenburg-smart-district-cooling, viewed 22 December 2020; Celsius City, "District cooling Helsingborg, Sweden", 14 February 2020, https://celsiuscity.eu/district-cooling-in-helsingborg-sweden; Euroheat & Power, "Country by country 2019", op. cit. note 264; EMSD Energy Land, op. cit. note 262.
- 270 IRENA, op. cit. note 144.
- 271 The developments are part of the visionary Chula Smart City Project, which seeks to sustainably rejuvenate and redevelop the Siam Square and Suan Luang Sam Yan commercial areas. Expected to be fully completed in 2027, the plant will be developed over three phases, with its first phase expected to be operational in late 2022. From Cool Coalition, "Consortium secures new \$329M contract for district cooling system in the heart of Bangkok", https://coolcoalition.org/consortium-secures-new-329m-contract-for-district-cooling-system-in-the-heart-of-bangkok, viewed 7 November 2020.
- 272 Tractebel, "District Cooling System at Amaravati Government Complexes in India", https://tractebel-engie.com/en/news/2019/ district-cooling-system-at-amaravati-government-complexes-inindia, viewed 10 January 2021.
- 273 Cool Coalition, op. cit. note 271.
- 274 M. G. Fernández et al., Efficient District Heating and Cooling Systems in the EU: Case Studies Analysis, Replicable Key Success Factors and Potential Policy Implications (Luxembourg:

- Publications Office of the European Union, 2016), https://publications.jrc.ec.europa.eu/repository/bitstream/JRC104437/study%20on%20efficient%20dhc%20systems%20in%20the%20eu%20-dec2016_final%20-%20public%20report6.pdf.
- 275 Ibid.
- 276 B. Radowitz, "Stockholm plans world's first carbon-negative district heating", Recharge, 28 January 2020, https://www.rechargenews.com/transition/stockholm-plans-world-s-first-carbon-negative-district-heating/2-1-745582; Smart City Sweden, "Stockholm innovates district heating with new solutions and renewable sources", https://smartcitysweden.com/best-practice/401/stockholm-innovates-district-heating-with-new-solutions-and-renewable-sources, viewed 20 January 2021.
- 277 A. Mishra, "Data science: The key tool cities need to reduce carbon emissions", Forbes, 13 July 2020, https://www.forbes.com/sites/ankitmishra/2020/07/13/data-science-the-key-tool-cities-need-to-reduce-carbon-emissions; European Automobile Manufacturers Association, Review of the Alternative Fuels Infrastructure Directive (Brussels: June 2020), https://www.acea.be/uploads/publications/ACEA_Position_Paper-Review_of_Alternative_Fuels_Infrastructure_Directive.pdf.
- 278 Around 6.5 million EV chargers were private, light-duty vehicle slow chargers in homes, multi-dwelling buildings and workplaces. The number of publicly accessible slow chargers was 598,000 (52% in China), while public fast chargers totalled 272,000 (82% in China). From IEA, Global EV Outlook 2020, op. cit. note 178.
- 279 Based on information and sources used throughout this section.
- 280 Adelaide City Council, Carbon Neutral Adelaide Action Plan 2016-2021 (Adelaide: 2016), https://d31atr86jnqrq2.cloudfront.net/docs/action-plan-carbon-neutralpdf.pdf.
- 281 Chargefox, "Chargefox opens South Australia's first ever ultrarapid EV charging station in Keith", 10 March 2020, https://www. chargefox.com/chargefox-opens-south-australias-first-ever-ultrarapid-ev-charging-station-in-keith.
- Table 2 from the following sources: 2,354 EV chargers in Los Angeles as of March 2020, from PlugShare, "Best EV charging stations in Los Angeles", https://www.plugshare. com/directory/us/california/los-angeles, viewed 29 October 2020; Los Angeles population of 3.98 million as of 1 July 2019, from US Census Bureau, "Population estimates, July 1, 2019", https://www.census.gov/quickfacts/fact/table/US/PST045219, viewed 29 October 2020; Los Angeles renewable electricity share in 2018 from LADWP, 2018 Power Content Label (Los Angeles: July 2019), https://www.energy.ca.gov/sites/default/ files/2020-01/2018_PCL_LADWP.pdf; San Jose EV chargers per million population from A. Bui, P. Slowik and N. Lutsey, Undate on Electric Vehicle Adoption Across U.S. Cities (Washington, DC: ICCT, August 2020), https://theicct.org/sites/default/files/ publications/EV-cities-update-aug2020.pdf; San Jose renewable electricity share in 2018 from San José Clean Energy, 2018 Power Content Label (San Jose: July 2019), https://sanjosecleanenergy. org/wp-content/uploads/2020/05/SJCE-2018-Power-Content-Label.pdf; EV chargers per million population for Amsterdam, Beijing, London, Oslo, Paris and Stockholm from D. Hall and N. Lutsey, Electric Vehicle Charging Guide for Cities (Washington, DC: ICCT, 2020), p. 8, https://theicct.org/sites/default/files/ publications/EV_charging_guide_03162020.pdf; country-level data on renewable shares for 2019 based on IEA, "Countries and regions", https://www.iea.org/countries, viewed 29 October 2020; Chinese cities from Hall and Lutsey, op. cit. this note; D. Hall, H. Cui and N. Lutsey, Electric Vehicle Capitals: Showing the Path to a Mainstream Market (Washington, DC: ICCT, November 2019), https://theicct.org/sites/default/files/ publications/EV_Capitals_2018_20191121.pdf; Statista, "Number of public electric vehicle charging stations in Shanghai China 2019, by type", https://www.statista.com/statistics/1035822/ china-shanghai-public-electric-vehicle-charging-station-numberby-type, updated 19 May 2020; Stockholm renewable electricity share based on CDP data received October 2020.
- 283 A. Krok, "Oslo will build wireless chargers for electric taxis in zeroemissions push", RoadShow CNET, 22 March 2019, https://www. cnet.com/roadshow/news/oslo-wireless-chargers-electric-taxifleet; B. Harvorson, "World's first high-power wireless charging for taxis uses Jaguar I-Pace, in Oslo", Green Car Reports, 24 June 2020, https://www.greencarreports.com/news/1128628_firsthigh-power-wireless-charging-jaguar-i-pace-taxis-oslo.



- 284 S. Hanley, "NYC adds 50 Envision off-grid solar EV charging stations", CleanTechnica, 27 December 2018, https://cleantechnica.com/2018/12/27/nyc-adds-50-envision-off-grid-solar-ev-charging-stations.
- 285 In 2019, EDP (Energias de Portugal) announced the installation of 30 ultra-fast charging stations for EVs in the state of São Paulo. Audi, Porsche and Volkswagen partnered with EDP on this project, contributing to the vehicles testing and homologation of the infrastructure. The project costs an estimated USD 6 million and will include 29 stations of 150 kW (DC), 1 station of 350 kW (DC) and 30 devices of 22 kW (AC). From Energias de Portugal (EDP), "EDP anuncia a primeira rede de recarga ultrarrápida de veículos elétricos do Brasil", November 2019, https://www.edp.com.br/noticias/edp-anuncia-a-primeirarede-de-recarga-ultrarrapida-de-veiculos-eletricos-do-brasil, and from EDP, "EDP announces electric mobility project with Audi, Porsche and VW for Brazil", 23 October 2019, https:// www.edp.com/en/news/2019/10/23/edp-announces-electricmobility-project-audi-porsche-and-vw-brazil. In 2019, the Metropolitan Regional Council of Santiago, along with Copec (Compañia de Petroleos de Chile), launched a public-private partnership to develop the largest charging infrastructure for EVs in South America with 104 charging points. Each point has a capacity of 22 kW, and the project cost around USD 2.5 million. From Gobierno de Santiago de Chile, "Santiago estrena nueva red de carga pública para vehículos eléctricos", October 2019, https://www.gobiernosantiago.cl/nueva-redde-carga-vehiculos-electricos, and from Empresas COPEC, "COPEC launches new EV public charging network", 25 October 2019, https://www.empresascopec.cl/en/noticia/ copec-launches-new-ev-public-charging-network.
- 286 Everoze, V2G Global Roadtrip: Around the World in 50 Projects (Bristol, UK: 2018), http://everoze.com/app/uploads/2018/10/ UKPN001-S-01-H-V2G-global-review-compressed.pdf; IRIS Smart Cities, "More than just mobility... an 'e-revolution': Utrecht installs world's first public charge and discharge electric vehicle stations", 31 January 2019, https://irissmartcities.eu/content/more-justmobility%E2%80%A6-%E2%80%98e-revolution%E2%80%99utrecht-installs-world%E2%80%99s-first-public-charge-and; The Mobility House, "Johan Cruijff Arena in Amsterdam and The Mobility House set the pace for the future of electric mobility", press release (Amsterdam: 9 December 2019), https://www. mobilityhouse.com/int_en/magazine/press-releases/the-mobilityhouse-amsterdam-arena-v2g-project.html; Arnhem from Elaadnl, "Testing vehicle to grid (V2G) possibilities in the INVADE project, with surprising results", 20 December 2019, https://www.elaad. nl/news/testing-vehicle-to-grid-v2g-possibilities-in-the-invadeproject-with-surprising-results; Cranfield from E.ON, "Parking up to power business: E.ON and Nissan announce major V2G project milestone", 6 August 2020, https://www.eonenergy.com/ About-eon/media-centre/eon-nissan-v2g-milestone.
- 287 Such collaborative initiatives are key to ensuring that EV charging does not burden the grid but instead provides an opportunity to smoothly integrate high shares of renewable energy (particularly variable solar and wind power) by coupling the electricity and transport sectors. From M. Motyka, "Renewables (em)power smart cities", Deloitte, 5 March 2019, https://www2.deloitte.com/xe/en/insights/industry/power-and-utilities/smart-renewable-cities-wind-solar.html; M. Kane, "Nuvve announces vehicle-to-grid (V2G) pilot programs", InsideEVs, 3 January 2019, https://insideevs.com/news/341858/nuvve-announces-vehicle-to-grid-v2g-pilot-programs.
- 288 See, for example, National Commission on Energy Policy, Task Force on Biofuels Infrastructure (Washington, DC: 2019), https:// bipartisanpolicy.org/wp-content/uploads/2019/03/biofuelstaskforce.pdf; US Department of Energy (DOE), Office of Energy Efficiency & Renewable Energy, "Hydrogen delivery", https:// www.energy.gov/eere/fuelcells/hydrogen-delivery, viewed 29 October 2020; IRENA, op. cit. note 4.
- 289 As of 2019, the United States had at least 613 biodiesel (B20 or above) fuelling stations and more than 3,777 ethanol (E85) fuelling stations, from Alternative Fuels Data Center, "U.S. alternative fueling stations by fuel", https://afdc.energy.gov/data/10332, viewed 20 September 2020; D. DeRamus and C. Cain, Biodiesel Distribution in the U.S. and Implications for RFS2 Volume Mandates (Washington, DC: Bates White Economic Consulting, July 2016), https://www.bateswhite.com/media/publication/116_2016.07.11%20Biodiesel%20paper%20final.pdf. In Europe, at least 457 stations were selling pure (100%

- biomethane), and more than 500 additional stations were selling blended biomethane, in 2019, from NGV Europe, "NGVA Europe marks the 200th European LNG fuelling station with a revamp of its stations map", press release (Brussels: 14 May 2019), https://www.ngva.eu/wp-content/uploads/2019/05/PRESS-RELEASE_NGVA-Europe_200LNGstations_map-update_20190514.pdf; European Biogas Association, *Biomethane in Transport* (Brussels: April 2016), https://www.europeanbiogas.eu/wp-content/uploads/2019/07/Biomethane-in-transport.pdf.
- 290 Jing, op. cit. note 191.
- 291 R. Kotrba, "Targray opens new biodiesel terminal in Antwerp, Belgium", Biodiesel Magazine, 7 October 2019, http://www.biodieselmagazine.com/articles/2516809/ targray-opens-new-biodiesel-terminal-in-antwerp-belgium.
- 292 M. Sapp, "Eco-Energy's ethanol distribution facility in Phoenix enters into final stage of construction", Biofuels Digest, 6 February 2020, https://www.biofuelsdigest.com/bdigest/2020/02/06/ eco-energys-ethanol-distribution-facility-in-phoenix-enters-intofinal-stage-of-construction.
- 293 US DOE, op. cit. note 288.
- 294 Japan remained the leader with at least 113 hydrogen filling stations, followed by Germany (81 stations) and the United States (64). In China, the number of hydrogen refuelling stations increased three-fold in 2019 (from 20 to 61). From IEA, Global EV Outlook 2020, op. cit. note 178.
- 295 H2Stations, "Hydrogen refuelling stations worldwide", https:// www.h2stations.org, viewed 29 October 2020.
- 296 Shell, "Hydrogen fuel", https://www.shell.com/energy-andinnovation/new-energies/hydrogen.html, viewed 12 October 2020
- 297 The station will have the capacity to supply up to 1,600 kilograms of hydrogen per day. From 2022 (when it is expected to become operational), the station will serve the region's fleet of 14 Alstom Coradia iLint hydrogen trains, following the announcement that the region's initial two trains successfully completed an 18-month, 180,000-kilometre test phase at the end of February 2020. From O. Cuenca, "Construction launched for Bremervörde hydrogen train filling station", International Railway Journal, 28 July 2020, https://www.railjournal.com/technology/construction-launched-for-bremervorde-hydrogen-train-filling-station.

FINANCING AND INVESTMENT IN CITIES

- 1 Frankfurt School United Nations Environment Programme (UNEP) Collaborating Centre for Climate & Sustainable Energy Finance (FS-UNEP Centre) and BloombergNEF, Global Trends in Renewable Energy Investment 2020 (Frankfurt: 2020), http:// www.fs-unep-centre.org.
- 2 BloombergNEF, "Clean Energy Investment Trends, 1H 2020" (London: 13 July 2020), https://data.bloomberglp.com/professional/sites/24/BNEF-Clean-Energy-Investment-Trends-1H-2020.pdf.
- 3 Knowledge Lab for Public-Private Partnerships, www.pppKnowledgeLab.org, viewed 18 September 2020.
- 4 CDP and C40 Cities, The Demand for Financing Climate Projects in Cities (London: 2018), https://www.transparency-partnership. net/system/files/document/C40_CFF_CDP_Infrastructure_ projects_report.pdf.
- Box 1 from the following sources: B. Buchner et al., Global Landscape of Climate Finance 2019 (London: Climate Policy Initiative, 2019), https://www.climatepolicyinitiative.org/publication/updated-view-on-the-global-landscape-of-climate-finance-2019; J. Hogg, "Financing sustainable cities: How we're helping Africa's cities raise their credit ratings", World Bank, 24 October 2013, https://www.worldbank.org/en/news/feature/2013/10/24/financing-sustainable-cities-africacreditworthy; Cities Climate Finance Leadership Alliance, http://www.citiesclimatefinance.org, viewed 20 January 2021.
- 6 City Snapshot: Palmas from Institut Brasileiro de Geografia e Estatistica, "Palmas: Panorama", https://cidades.ibge.gov.br/ brasil/to/palmas/panorama, viewed 10 December 2020, and from International Urban Cooperation Program, "Programa Palmas Solar", 2018, http://iuc-la.eu/wp-content/uploads/2020/03/ POR_Palmas__TO_-_Programa_Palmas_Solar.pdf.
- 7 ICLEI-Local Governments for Sustainability, "Climate finance decision-making tree", https://www.iclei.org/en/publication/ climate-finance-decision-making-tree, viewed 10 October 2020.
- M. Campbell et al., Land Value Capture to Fund Transport Investment in Cities (Wellington, New Zealand: BRANZ, 2016), https://www.researchgate.net/publication/303995861_Land_value_capture_to_fund_transport_investments_in_cities.
- Box 2 and Figure 16 based on the following sources: Gofossilfree.org, "Divestment commitments overview", https:// gofossilfree.org/divestment/commitments, viewed 14 December 2020; C40 Cities Climate Leadership Group, Divesting from Fossil Fuels, Investing in Our Future: A Toolkit for Cities (London: 2020), https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q0000 00MmBe/0sK2VDoRdYwGyPuXNGTakGB47EnJKXFUE5qWGpJ Eawg; DivestInvest.org, "Commitments to DivestInvest", https:// www.divestinvest.org/commitments, viewed 27 December 2020; J. C. Figueira, "12 major cities commit to divest from fossil fuel companies", Climate Action, 25 September 2020, http://www. climateaction.org/news/12-major-cities-commit-to-divest-fromfossil-fuel-companies; M. Rowling, "Cities promise to divest from fossil fuels to boost green recovery", Thomson Reuters Foundation News, 22 September 2020, https://news.trust.org/ item/20200922131602-u2ee2.
- 10 ICLEI, op. cit. note 7.
- E. Ahmad, Infrastructure Finance in the Developing World: Public Finance Underpinnings for Infrastructure Financing in Developing Countries (Washington, DC: Intergovernmental Group of Twenty-Four and Global Green Growth Institute, 2015), http://www.g24.org/ wp-content/uploads/2016/05/MARGGK-WP05.pdf.
- CORENA, "Citizens own renewable energy network Australia Inc.", https://corenafund.org.au, viewed 11 December 2020; Asia from Indiegogo, "Coffee for biogas energy & farmer's climate school", https://www.indiegogo.com/projects/coffee-for-biogas-energyfarmer-s-climate-school, viewed 15 October 2019, and from Indiegogo, "PAYG community solar pumps for marginal farms", https://www.indiegogo.com/projects/payg-community-solarpumps-for-marginal-farmers, viewed 15 October 2019; Europe from S. Mikulcic, "Crowd investing for solar roofs inKriževci" (Brussels: EU Mayors, 2020), https://www.eumayors.eu/index. php?option=com_attachments&task=download&id=932; North America from Start Engine, "Sun Fund", https://www.startengine. com/sun-fund-dc, viewed 15 October 2019, from Start Engine, "Solar Direct", https://www.startengine.com/solar-direct, viewed 15 October 2019, and from Start Engine, "Power2Peer", https:// www.startengine.com/power2peer, viewed 15 October 2019.

- 13 Neighborly, "Fiber broadband infrastructure to connect communities: A full-service solution for open access networks", https://neighborly.com/learn/history-of-municipal-bondschapter-2, viewed 15 October 2019; Invesco, Primer on Municipal Bonds: What Investors Need to Know (Atlanta, GA: September 2019), https://www.opiniopro.com/2019/05/invesco/ primer-on-municipal-bonds-what-investors-need-to-know-pdf-2.
- 14 R. Nallathiga, "Municipal bonds as a source of finance for urban infrastructure development in India", prepared for the 23rd Thinkers and Writers Forum of Skoch Summit, 11-12 June 2015, pp. 1-15, https://www.researchgate.net/publication/278302216_Municipal_Bonds_as_a_Source_of_Finance_for_Urban_Infrastructure_Development_in_India; J. Hudson, "How to invest in municipal bonds: Making cities smarter with municipal bonds", MunicipalBonds.com, 3 August 2017, https://www.municipalbonds.com/investing-strategies/making-smarter-cities-with-municipal-bonds.
- Table 3 from Climate Bonds Initiative (CBI), personal communication with REN21, 28 September 2020. Sidebar 6 based on the following sources: International Energy Agency (IEA), Renewable Energy Market Update (Paris: 2020), https://www.iea.org/reports/ renewable-energy-market-update; S. Trivedi, I. Ray and G. Vulturius, Scaling Up Rooftop Solar Power in India: The Potential of Solar Municipal Bonds (New Delhi: Climate Policy Initiative, Indian Council for Research on International Economic Relations and Stockholm Environment Institute, 2018), https://climatepolicyinitiative.org/ wp-content/uploads/2018/02/Scaling-up-Rooftop-Solar-Power-in-India-The-Potential-of-Solar-Municipal-Bonds.pdf; R. Gillard et al., Affordable and Clean Energy for All: Lessons on Rooftop Solar from Delhi, India (Washington, DC: Coalition for Urban Transitions, 2018), http://newclimateeconomy.net/content/cities-working-papers; S. Graber, P. Sachiko and J. Sherwood, Under the Grid: Improving the Economics and Reliability of Rural Electricity Service with Undergrid Minigrids (Basalt, CO: Rocky Mountain Institute, 2018), www.rmi.org/ insight/under-the-grid.
- J. Chen, "Revenue bond", Investopedia, https://www.investopedia. com/terms/r/revenuebond.asp, updated 6 March 2018.
- 7 S. Brand and J. Steinbrecher, "Green bonds a sustainable alternative for municipal infrastructure finance?", KfW Research Focus on Economics, no. 245 (2019), https://www.kfw.de/PDF/ Download-Center/Konzernthemen/Research/PDF-Dokumente-Fokus-Volkswirtschaft/Fokus-englische-Dateien/Fokus-2019-EN/Fokus-No.-245-March-2019-Green-Bonds.pdf.
- l8 Ibid
- 19 United Nations Framework Convention on Climate Change, "Gothenburg Green Bonds Sweden", 2020, https://unfccc.int/climate-action/momentum-for-change/ financing-for-climate-friendly/gothenburg-green-bonds.
- The United States issued USD 51.3 billion in 2019, an increase of 44% over 2018. China issued USD 31.3 billion in 2019, up only 1% from the previous year. Europe, however, experienced the highest growth, with a USD 50 billion increase equivalent of 57% over 2018. CBI, Green Bonds: Global State of the Market 2019 (London: 2020), https://www.climatebonds.net/resources/reports/greenbonds-global-state-market-2019.
- 21 International Finance Corporation (IFC), Climate Investment Opportunities in Cities. An IFC Analysis (Washington, DC: 2018), https://www.ifc.org/wps/wcm/connect/875afb8f-de49-460e-a66a-dd2664452840/201811-CIOC-IFC-Analysis.pdf?MOD= AJPERES&CVID=mthPzYg.
- 22 CCFLA, State of City Climate Finance 2015 (New York: 2015), http://ccfla.wpengine.com/wp-content/uploads/2015/12/CCFLA-State-of-City-Climate-Finance-2015.pdf.
- 23 T. Vinod, "Infrastructure lending must be based on environmental and social safeguards", Brookings, 1 June 2015, https://www. brookings.edu/blog/future-development/2015/06/01/infrastructurelending-must-be-based-on-environmental-and-social-safeguards.
- 24 CCFLA, op. cit. note 3.
- V. Bennet, "Green Climate Fund makes Eur87 million available to EBRD Green Cities", European Bank for Reconstruction and Development, 2 July 2019, https://www.ebrd.com/news/2019/greenclimate-fund-makes-87-million-available-to-ebrd-green-cities-.html.
- 26 United Nations Conference on Trade and Development (UNCTAD), Supporting Infrastructure Development to Promote Economic Integration: The Role of Public and Private Sectors (Geneva: March 2013), https://unctad.org/meetings/en/SessionalDocuments/cimem6d2_en.pdf.

// REN**21**

- 27 ICLEI, op. cit. note 7; World Bank, "Main financing mechanisms for infrastructure projects", Public-Private Partnership Legal Resource Center, 2016, https://ppp.worldbank.org/ public-private-partnership/financing/mechanisms.
- 28 World Bank, op. cit. note 27.
- 29 City Snapshot: North Lombok from Marlion LLC, "Jumlah Penduduk dan Rasio Jenis Kelamin Menurut Kabupaten/Kota di Provinsi NTB Tahun 2008", 21 August 2017, https://web. archive.org/web/20170821170139/http://marlionllc.com/jumlah-penduduk-dan-rasio-jenis-kelamin-menurut-kabupatenkota-di-provinsi-ntb-tahun-2008, and from B. Z. E. Cedrick and W. Long. "Investment motivation in renewable energy: A PPP approach", Energy Procedia, vol. 115 (June 2017), pp. 229-38, https://www.sciencedirect.com/science/article/pii/S1876610217322208.
- 30 ICLEI, op. cit. note 7.
- 31 Ibid
- 32 UNCTAD, op. cit. note 26.
- 33 P. Dumas and T. Garabetian, "Financing deep geothermal: Innovating schemes for new business models", presented at European Geothermal Congress 2019, http://europeangeothermalcongress.eu/wp-content/ uploads/2019/07/105.pdf.
- 34 I. Granoff, J. R. Hogarth and A. Miller, "Nested barriers to low-carbon infrastructure investment", Nature Climate Change, vol. 6 (December 2016), https://www.nature.com/articles/nclimate3142.
- 35 World Bank, Private Participation in Infrastructure (PPI) 2019 Annual Report (Washington, DC: 2020), https://ppi.worldbank. org/content/dam/PPI/documents/private-participation-infrastructure-annual-2019-report.pdf.
- 36 Ibio
- 37 C40 Cities, Establishing a City Green Bank: Best Practice Guide (London: 2020), https://www.c40knowledgehub.org/s/article/ Establishing-a-City-Green-Bank-Best-Practice-Guide.
- 38 Ibid
- 39 Ibid.
- 40 World Bank, "Power purchase agreements (PPAs) and energy purchase agreements (EPAs)", 9 October 2019, https://ppp. worldbank.org/public-private-partnership/sector/energy/ energy-power-agreements/power-purchase-agreements.
- 41 Urban Grid, "Types of power purchase agreements for offsite renewable energy projects", 21 January 2019, https://www.urbangridsolar.com/types-of-power-purchase-agreements-for-offsite-renewable-energy-projects.
- 42 Dumas and Garabetian, op. cit. note 33.
- 43 Center for Climate and Energy Solutions (C2ES), *Buying Clean Electricity: How Cities Benefit from Power Purchase Agreements* (Arlington, VA: 2018), https://www.c2es.org/site/assets/uploads/2018/09/how-cities-benefit-from-ppas.pdf.
- 44 Ibid.
- 45 Ibid.
- 46 C40 Knowledge, "How cities can create demand for large-scale clean energy generation", March 2019, https://www.c40knowledgehub.org/ s/article/How-cities-can-create-demand-for-large-scale-cleanenergy-generation.
- 47 L. Shaver and H. B. Ratz, "4 creative ways cities are transitioning to a clean energy future", WRI Blog, 26 February 2019, https://www.wri.org/blog/2019/02/4-creative-ways-cities-are-transitioning-clean-energy-future; City of Melbourne, "Melbourne renewable energy project: A new generation of energy", https://www.melbourne.vic.gov.au/business/sustainable-business/mrep/Pages/melbourne-renewable-energy-project.aspx, viewed 15 October 2019.
- 48 Shaver and Ratz, op. cit. note 47; City of Melbourne, op. cit. note 47.
- 49 Projects include all renewable energy types, a majority of which are solar PV and wind power. These numbers do not represent actual investment flows, but rather project costs, for which some cities are still in need of financing. As such it can be seen as a demand for financing. Dataset is not comprehensive and misses key countries such as China (except Hong Kong) and the United Arab Emirates. CDP Matchmaker Data, personal communication with REN21, 5 November 2020.

- First launched in 2015, the Transformative Actions Program (TAP), led by ICLEI and supported by its 14 partners, aims to catalyse and improve capital flows to cities, towns and regions by strengthening their capacity to access climate finance and attract investment. Since its launch, the majority of the applications have come from the energy sector, representing a significant and growing part of the TAP project portfolio. Most applications come from Africa and Latin America and the Caribbean, followed by Asia. ICLEI, "Transformative Actions Program", https://www.iclei.org/en/TAP.html, viewed 19 December 2020; E. Mogyorósy, ICLEI, personal communication with REN21, 1 December 2020.
- 51 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 52 Asian Development Bank, "Cambodia: Cambodia Solar Power Project", https://www.adb.org/projects/50248-001/main#projectoverview, viewed 11 December 2020; "Cambodia Solar Energy Profile", Solar Magazine, 21 October 2019, https://solarmagazine. com/solar-profiles/cambodia.
- J. S. Bunachita, "Renewable energy: Cebu companies go green", Cebu Daily News, 20 June 2018, https://cebudailynews.inquirer. net/180705/renewable-energy-cebu-companies-go-green.
- 54 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 55 Ibid
- 56 Y. Nishida, Renewable Energy Institute, personal communication with REN21, 19 October 2020.
- 57 Ibid.; General Incorporated Association Green Finance Promotion, http://greenfinance.jp, viewed 19 October 2020 (in Japanese).
- 58 Nishida, op. cit. note 56.
- 59 Ibid
- 60 Ibid.; Japan for Sustainability, "Small hydropower brings possibility of locally generated electricity for local consumption", JFS Newsletter, no. 95 (July 2010), https://www.japanfs.org/en/ news/archives/news_id030154.html.
- Institute for Global Environmental Strategies (IGES), Involvement of the Local Government in the Local Production for Local Consumption of Energy (Kitakyushu City, Japan: 2016), https://www.iges.or.jp/en/publication_documents/pub/issue/en/5487/Involvement_of_the_Local_Government_in_the_Local_Production_for_Local_Consumption_of_Energy_EN.pdf.
- 62 IGES, op. cit. note 61.
- 63 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 64 Ibid
- 65 Y. Zhang, US National Renewable Energy Laboratory, personal communication with REN21, 9 October 2020.
- 66 International Institute for Sustainable Development, Public Finance for Renewable Energy in China: Building on International Experience (Winnipeg, Canada: 2014), https://www.iisd.org/publications/publicfinance-renewable-energy-china-building-international-experience.
- 67 Zhang, op. cit. note 65.
- 68 Ibid.
- 69 Ibid.
- 70 M. Jing and C. Qian, eds., "River water is pumped ashore to construct a river water source heat pump project in Nanjing Jiangbei New District", Nanjing Daily, 28 May 2018, http://js.cri. cn/20180528/ad398848-fd63-b4da-dacc-c1e05f3a665e.html (using Google Translate).
- Zhang, op. cit. note 65; Shanghai Municipal Development and Reform Commission, "Notice of the Shanghai Municipal Development and Reform Commission on doing a good job in the construction of photovoltaic power generation projects in 2020", 14 April 2020, http://fgw.sh.gov.cn/zgjjl/20200414/8b2fae3a7da34be7acc062c4ff599cbb.html (using Google Translate); EcoHZ, "Beijing Yanqing low wind speed in China", https://www.ecohz.com/renewable-energy-solutions/powerplants/beijing-yanqing-low-wind-speed-in-china, viewed 10 December 2020; Guangzhou and Shenzhen from Guangdong Provincial Development and Reform Commission, "Notice of the Guangdong Provincial Energy Administration on promoting the development and construction of decentralized wind power", 29 April 2019, http://drc.gd.gov.cn/ywtz/content/post_2286523.html (using Google Translate).
- 72 Zhang, op. cit. note 65.

- 73 CBI, China Green Bond Market: 2019 Research Report (London: 2020), https://www.climatebonds.net/files/releases/joint_release-cbi_ccdc_hsbc-china-green-bond-market-report2019_en_29062020-final-.pdf.
- 74 Ibid
- 75 CBI, "Green Bond Fact Sheet" (London: 2020), https://www.climatebonds.net/files/files/2020-08_CN_Datang_Henan_ Power_Generation.pdf.
- 76 GIZ China, "Transport & Power-to-X (PtX) in China", 17 August 2020, https://www.sustainabletransport.org/archives/7846; "Zhangjiakou speeds up to build a Hydrogen Energy City, Renewable energy production highlights the advantages", 16 June 2020, http://guangfu.bjx.com.cn/news/20200616/1081324.shtml (using Google Translate).
- 77 Guyuan Rong Media Center, "With a total investment of 2.03 billion yuan, the equipment installation of the Hebei Guyuan Hydrogen Generation Project has been completed!", 8 December 2020, https://wind.in-en.com/html/wind-2396041.shtml (using Google Translate).
- 78 B. Finamore and H. M. Kim, "How EV charging can clean up China's electricity grid", Natural Resources Defense Council, 23 June 2020, https://www.nrdc.org/experts/barbara-finamore/ how-ev-charging-can-clean-chinas-electricity-grid.
- 79 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 80 A. Bhardwaj, New York University, personal communication with REN21, 17 September 2020.
- 81 Trivedi, Ray and Vulturius, op. cit. note 15.
- 82 Bhardwaj, op. cit. note 80; A. Bhardwaj, F. de Lorenzo and M-H. Zerah, New Powers: How India's Smart Cities Are Governing and Transitioning to Low Carbon Energy (New Delhi: Centre for Policy Research, July 2019), http://www.indiaenvironmentportal.org.in/files/file/New%20Powers.pdf.
- 83 Bhardwaj, de Lorenzo and Zerah, op. cit. note 82.
- 84 Ibid.
- 85 Ibid. Kalyan had invested INR 192 crore (USD 26.2 million) and Surat INR 155 crore (USD 21.2 million) in waste-to-energy.
- 86 Ibid. Pune had invested INR 126 crore (USD 17.2 million) and Dharamshala INR 63.06 crore (USD 8.6 million) in e-mobility.
- 87 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 88 Ibid.
- 89 Dedicated funds available for renewable energy projects across the continent include but are not limited to: the Renewable Energy Program for Sub-Saharan Africa (RFP), the Sustainable Energy Fund for Africa (SEFA), the Green Enterprise Finance Accelerator (GEFA), Global Innovation Lab for Climate Finance, Off-Grid Market Development Fund (OMDF), the Dutch Fund for Climate and Development, the Urban and Municipal Development Fund for Africa and the Beyond the Grid Fund for Africa.
- 90 NS Energy, "Benban Solar Park", https://www.nsenergybusiness. com/projects/benban-solar-park, viewed 8 January 2021.
- 91 J. M. Takouleu, "Rwanda: Kigali Green City project receives Eur9.6m grant from KfW", Afrik21, 14 February 2020, https://www.afrik21.africa/ en/rwanda-kigali-green-city-project-receives-e9-6m-grant-from-kfw.
- 92 I. Magoum, "Ghana: Elecnor delivers a 6.5 MWp photovoltaic solar power plant in Lawra", Afrik21, 13 October 2020, https://www.afrik21.africa/en/ghana-elecnor-delivers-a-6-5-mwp-photovoltaic-solar-power-plant-in-lawra.
- 93 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 64 K. Fullertonk, "South Africa's REIPP", Sense and Sustainability, 2 April 2019, https://www.senseandsustainability.net/2019/04/02/ south-africas-reippp.
- 95 A. Eberhard, J. Kolker and J. Leigland, South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons (Washington, DC: World Bank, 2014), https://www.ee.co.za/ wp-content/uploads/2014/06/southafrica-reipp-report-6-5.pdf.
- 96 A. Richter, "Open Mountain Energy secures 15 MW PPA for two geothermal projects under construction", Think GeoEnergy, 27 February 2020, https://www.thinkgeoenergy.com/openmountain-energy-secures-15-mw-ppa-for-two-geothermalprojects-under-construction.
- 97 NS Energy, "Siraj-1 Solar Power Project", https://www. nsenergybusiness.com/projects/siraj-1-solar-power-project, viewed 8 January 2021.

- 98 C40 Cities, "C40 Good Practice Guides: Johannesburg Green Bond", 15 February 2016, https://www.c40.org/case_studies/c40-good-practice-guides-johannesburg-green-bond.
- 99 D. Barbuscia and A. Ramnarayan, "Egypt becomes first Arab country to issue green bonds with \$750 million deal", Reuters, 29 September 2020, https://www.reuters.com/article/idUSKBN26K1MJ.
- 100 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 101 Ibid.
- 102 J. M. Vassallo, Afrontando el reto de conectar y mejorar las ciudades (Caracas: CAF, 2019), http://scioteca.caf.com/handle/123456789/1376.
- 103 World Bank, op. cit. note 35; Gobierno Regional Metropolitano de Santiago, "Santiago estrena nueva red de carga pública para vehículos eléctricos", 18 October 2019, https://www. gobiernosantiago.cl/nueva-red-de-carga-vehiculos-electricos.
- 104 Piauí Governo do Estado, "Governo retoma licitação da PPP das Miniusinas de Energia Solar", 23 June 2020, https://www.pi.gov.br/ noticias/ppp-das-miniusinas-de-energia-solar-tem-licitacao-retomada.
- 105 CanalEnergia, "Prefeitura de São Paulo estuda investir R\$ 32,6 milhões em energia solar", 21 August 2020, https://www.canalenergia.com.br/noticias/53144542/prefeitura-de-sao-paulo-estuda-investir-r-326-milhoes-em-energia-solar; L. Morals, "Brazil's Copel to build 5-MW solar, biomass hybrid in Parana", Renewables Now, 5 March 2020, https://renewablesnow.com/news/brazils-copel-to-build-5-mw-solar-biomass-hybrid-in-parana-689695.
- 106 Norton Rose Fulbright, Renewable Energy in Latin America (London: 2017), https://www.nortonrosefulbright.com/-/media/ files/nrf/nrfweb/imported/renewable-energy-in-latin-america.pdf.
- 107 Iberdrola Mexico, "Grupo Modelo e Iberdrola anuncian acuerdo de suministro de energía eléctrica removable", 28 March 2017, https://www.iberdrolamexico.com/grupo-modelo-e-iberdrolaanuncian-acuerdo-de-suministro-de-energia-electrica-renovable.
- 108 Inter-American Development Bank (IDB), Expansión de las energías renovables no convencionales en América Latina y el Caribe: el rol de las instituciones financieras de Desarrollo (Washington, DC: 2016), https://publications.iadb.org/publications/spanish/document/Expansi%C3%B3n_de_las_energ%C3%ADas_renovables_no_convencionales_en_Am%C3%A9rica_Latina_y_el_Caribe_El_rol_de_las_instituciones_financieras_de_desarrollo_es_es.pdf.
- 109 Bancoldex, "Bancoldex será pionero en financiar inversiones verdes en negocios de micros y pequeños empresarios",
 9 October 2019, https://www.bancoldex.com/noticias/bancoldex-sera-pionero-en-financiar-inversiones-verdes-en-negocios-demicros-y-pequenos-empresarios-3403.
- 110 São Paulo Governo do Estado, "Governo de SP assina acordo para incentivo de energia solar", 13 June 2018, https://www.desenvolvesp.com.br/comunicacao/noticias/ governo-de-sp-assina-acordo-para-incentivo-de-energia-solar.
- 111 IDB, "BID Invest financia la expansión de la energía solar en Brasil junto a Sicredi", 12 February 2020, https://www.idbinvest.org/es/medios-y-prensa/bid-invest-financia-la-expansion-de-la-energia-solar-en-brasil-junto-sicredi.
- 112 Ciudad Luz, "¿Qué es el modelo ESCO?", 27 April 2020, https://ciudadluz.cl/2020/04/27/auto-draft/; Ciudad Luz, "Energía Solar", https://www.greenyellow.co/energia-solar, viewed 12 December 2020; GarperEnergy, "Financiación y Modelo ESCO en Colombia", http://www.garperenergy.com/ahorrar-energia-servicios/financiacion-esco, viewed 12 December 2020; EscoGD, "Projecto Solar", https://escogd.com.br/solucoes/3-projeto-solar, viewed 12 December 2020.
- 113 B. Bastit, "Resurgen los bonos verdes latinoamericanos", World Bank, 30 September 2019, https://blogs.worldbank.org/es/ voices/resurgen-los-bonos-verdes-latinoamericanos.
- 114 C40 Cities, Clean Energy Business Model Manual (London: November 2018), https://c40-production-images.s3.amazonaws. com/other_uploads/images/2008_C40_Clean_Energy_ Business_Model_Manual_-_Ezgi_Kelleher.original.pdf.
- 115 FS-UNEP Centre and BloombergNEF, op. cit. note 1.
- 116 Ibid.
- 117 Brand and Steinbrecher, op. cit. note 17.
- 118 Ibid.
- 119 CBI, op. cit. note 20.
- 20 CBI, The Green Bond Market in Europe 2018 (London: 2019), https://www.climatebonds.net/files/reports/the_green_bond_market_in_europe.pdf.

- 121 European PPP Expertise Center, Market Update: Review of the European PPP Market in 2019 (Luxembourg: 2020), https://www. eib.org/attachments/epec/epec_market_update_2019_en.pdf.
- 122 V. Spasic, "Ljubljana contracts third PPP project for energy renovation of public buildings", Balkan Green Energy News, 29 July 2020, https://balkangreenenergynews.com/ljubljana-contractsthird-ppp-project-for-energy-renovation-of-public-buildings.
- 123 "Commission for PPP helping municipalities adopt strategic approach", Balkan Green Energy News, 26 February 2018, https://balkangreenenergynews.com/commission-for-ppp-helping-municipalities-adopt-strategic-approach; B. Jovičić, "GGE puts into operation environmentally biomass boilers in school in Pirot", Balkan Green Energy News, 8 November 2017, https://balkangreenenergynews.com/gge-puts-into-operation-environmentally-friendly-biomass-boilers-school-pirot.
- 124 European Commission, "EU funding possibilities in the energy sector", https://ec.europa.eu/energy/funding-and-contracts/eu-funding-possibilities-in-the-energy-sector_en, viewed 2 October 2020.
- 125 The Celsius Project, "Riga, making a difference in the Baltic countries", https://celsiuscity.eu/riga-making-a-difference-in-thebaltic-countries, viewed 20 September 2020.
- 126 European Bank for Reconstruction and Development (EBRD), "EBRD puts on the heating in Banja Luka", 13 November 2017, https://www.ebrd.com/news/2017/ebrd-puts-on-the-heating-in-banja-luka.html.
- 127 B. Epp, "SDH prefeasibility studies for Serbian cities", solarthermalworld.org, 19 February 2020, https://www. solarthermalworld.org/news/sdh-prefeasibility-studies-serbian-cities.
- 128 T. De Atholia, G. Flannigan and S. Lai, Renewable Energy Investment in Australia (Sydney: Reserve Bank of Australia, 2020), https://www.rba.gov.au/publications/bulletin/2020/mar/pdf/ renewable-energy-investment-in-australia.pdf.
- 129 M. Mazengarb, "Rooftop solar already a pioneer in 'buy now, pay later' Bright founder says", One Step Off the Grid, 11 September 2020, https://onestepoffthegrid.com.au/rooftop-solar-already-apioneer-in-buy-now-pay-later-brighte-founder-says.
- 130 Ibid.
- 131 Off Grid Energy Independence, "Sydney switches to 100% renewable energy", 8 July 2020, https://www.offgridenergyindependence.com/ articles/21165/sydney-switches-to-100-renewable-energy.
- 132 C40 Knowledge, op. cit. note 46.
- 133 IFC, "Cleaner, cheaper power fuels a better future for Solomon Islanders", December 2019, https://www.ifc. org/wps/wcm/connect/news_ext_content/ifc_external_ corporate_site/news+and+events/news/impact-stories/ cleaner-cheaper-power-fuels-better-future-solomon-islanders.
- 134 Ibic
- 135 FS/UNEP Centre and BloombergNEF, op. cit. note 1.
- 136 S. Abbott et al., "Local Government Renewables Action Tracker" (Washington, DC: Rocky Mountain Institute and World Resources Institute, 2020), https://cityrenewables.org/ local-government-renewables-action-tracker.
- 137 See, for example: New Braunfels (Texas, US), from E. F. Merchant, "Texas municipal utility signs new super-low solar PPA", Greentech Media, 14 December 2018, https://www.greentechmedia.com/articles/read/utility-signs-new-low-solar-ppa-in-texas; Philadelphia (Pennsylvania, US), from Philadelphia Energy Authority, "Mayor signs legislation for large-scale purchase of renewable energy", 19 December 2018, https://philaenergy.org/philadelphia-mayor-signs-legislation-for-large-scale-purchase-of-renewable-energy; Washington, D.C. (US), from C40 Cities Climate Leadership Group, "How cities can create demand for large-scale clean energy generation", https://www.c40knowledgehub.org/s/article/How-cities-can-create-demand-for-large-scale-clean-energy-generation?language=en_US, viewed 15 October 2020.
- 138 Abbott et al., op. cit. note 136.
- J. Jeuch, Case Study: Cincinnati's Path to A 100 MW Solar Deal (Cincinnati, OH: American Cities Climate Challenge, 2020), https://cityrenewables.org/wp-content/uploads/2020/08/ CRA_Cincinnati_Case-Study.pdf.
- 140 A. Danigelis, "RBC becomes first Canadian bank to sign renewable energy deal", Environment + Energy Leader, 31 July 2020, https://www.environmentalleader.com/2020/07/ rbc-renewable-energy-deal.

- 141 Energy Northwest, "Horn Rapids Solar, Storage & Training Project", https://www.energy-northwest.com/energyprojects/ horn-rapids/Pages/default.aspx, viewed 8 January 2021.
- 142 CBI, Green Bond Fact Sheet: Sacramento Municipal Utility District (London: July 2020), https://www.climatebonds.net/files/files/2020-05_US_Sacramento_Municipal_Utility_District.pdf.
- 143 Climate Mayors Electric Vehicle Purchasing Collaborative, "What is the Collaborative", https://driveevfleets.org/what-is-the-collaborative, viewed 8 January 2021; ChargePoint, Inc., "Cities and towns", https://www.chargepoint.com/solutions/cities-and-towns, viewed 8 January 2021; EVgo, "Utility and government agencies", https://www.evgo.com/ev-charging-business/utility-companies, viewed 8 January 2021.
- 144 Los Angeles Cleantech Incubator, "Zero Emissions Mobility and Community Pilot Program Fund", https://laincubator.org/mobilitypilots, viewed 8 January 2021.
- 145 Granoff, Hogarth and Miller, op. cit. note 34; T. S. Schmidt, "Low-carbon investment risks and de-risking", *Nature Climate Change*, vol. 4 (April 2014), https://www.nature.com/articles/nclimate2112.
- 146 Granoff, Hogarth and Miller, op. cit. note 34; G. Floater et al., Global Review of Finance for Sustainable Urban Infrastructure (London and Washington, DC: Coalition for Urban Transitions, 2017), pp. 1-60, https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/01/NCE2017_CUT_GlobalReview_02012018. pdf; G. C. Unruh, "Understanding carbon lock-in", Energy Policy, vol. 28, no. 12 (2000), pp. 817-30, http://www.sciencedirect.com/science/article/pii/S0301421500000707.
- 147 Granoff, Hogarth and Miller, op. cit. note 34; Floater et al., op. cit. note 146; Unruh, op. cit. note 146.
- 148 Granoff, Hogarth and Miller, op. cit. note 34.
- 149 ICLEI, op. cit. note 50; Mogyorósy, op. cit. note 50.
- 150 Hudson, op. cit. note 14.
- 151 Granoff, Hogarth and Miller, op. cit. note 34.
- 152 European Committee of the Regions, "Financing climate action: opportunities and challenges for local and regional authorities" (Brussels: European Union, 2017), https://cor.europa.eu/en/engage/studies/Documents/Financing-climate-action.pdf.
- 153 Ibid
- 154 B. Petrie et al., Multi-level Climate Governance in South Africa. Catalysing Finance for Local Climate Action (Berlin / Cape Town: OneWorld, Sustainable Energy Africa and adelphi, 2018), https://www.adelphi.de/en/system/files/mediathek/bilder/Multi-level%20climate%20governance%20in%20South%20Africa%20-%20adelphi.pdf.
- 155 Organisation for Economic Co-operation and Development (OECD), "Challenges for infrastructure investment at subnational level", OECD Regions at a Glance 2016 (Paris: 2016), https://www. oecd-ilibrary.org/docserver/reg_glance-2016-en.pdf.
- 156 IFC, op. cit. note 21.
- 157 Ibid.; Floater et al., op. cit. note 146.
- 158 Granoff, Hogarth and Miller, op. cit. note 34; Schmidt, op. cit. note 145.
- 159 Granoff, Hogarth and Miller, op. cit. note 34; Schmidt, op. cit. note 145.
- 160 CCFLA, op. cit. note 22.
- 161 Ibid
- 162 World Bank, "City Creditworthiness Initiative: A partnership to deliver municipal finance", https://www.worldbank.org/en/topic/ urbandevelopment/brief/city-creditworthiness-initiative, viewed 30 December 2020.

CITIZEN PARTICIPATION

- See A. Rüdinger, "What is the citizen participation in the energy transition?" IDDRI, 26 April 2017, https:// www.iddri.org/en/publications-and-events/blog-post/ what-citizen-participation-energy-transition.
- D. Bidwell, "Thinking through participation in renewable energy decisions", Nature Energy, vol. 1 (May 2016), www.nature.com/ articles/nenergy201651.
- Ö. Yildiz, "Financing renewable energy infrastructures via financial citizen participation – The case of Germany", Renewable Energy, vol. 68 (August 2014), pp. 677-85, https://www.sciencedirect. com/science/article/abs/pii/S0960148114001293.
- 4 M. S. Henry, M. D. Bazilian and C. Markuson, "Just transitions: Histories and futures in a post-COVID world", Energy Research and Social Science, vol. 68 (October 2020), p. 101668, https:// www.ncbi.nlm.nih.gov/pmc/articles/PMC7351418.
- 5 S. R. Arnstein et al., "Being a 'citizen' in the smart city: Up and down the scaffold of smart citizen participation in Dublin, Ireland", GeoJournal, 1 January 1969, https://link.springer.com/ article/10.1007/s10708-018-9845-8.
- 6 M. Islar and H. Busch, ""We are not in this to save the polar bears!" The link between community renewable energy development and ecological citizenship", Innovation: The European Journal of Social Science Research, vol. 29, no. 3 (2016), pp. 303-19, https://www.tandfonline.com/doi/abs/10.1080/13511610.2016.1188684.
- 7 S. Haf and R. Robison, How Local Authorities Can Encourage Citizen Participation in Energy Transitions (London: UK Energy Research Centre, 2020), https://energy-cities.eu/wp-content/uploads/2020/05/ HafRobison_LAs-and-citizen-participation_published.pdf.
- 8 Islar and Busch, op. cit. note 6.
- 9 T. F. Luna et al., "The influence of e-carsharing schemes on electric vehicle adoption and carbon emissions: An emerging economy study", *Transportation Research Part D: Transport and Environment*, vol. 79 (February 2020), p. 102226, http://www.sciencedirect.com/science/article/pii/S1361920919309460.
- 10 Accenture, The New Energy Consumer: Unleashing Business Value in a Digital World (Dublin: 2020), https://www.accenture. com/_acnmedia/accenture/next-gen/insight-unlocking-value-of-digital-consumer/pdf/accenture-new-energy-consumer-final.pdf.
- 11 Ibio
- D. Litvine and R. Wüstenhagen, "Helping 'light green' consumers walk the talk: Results of a behavioural intervention survey in the Swiss electricity market", Ecological Economics, vol. 70, no. 3 (2011), pp. 462-74, https://www.sciencedirect.com/science/article/abs/pii/S0921800910004234?via%3Dihub.
- Deloitte, Deloitte Resources 2020 Study (Stamford, CT: 2020), https://www2.deloitte.com/content/dam/insights/us/articles/6655_Resources-study-2020/DI_Resources-study-2020. pdf; M. N. Conte and G. D. Jacobsen, "Explaining demand for green electricity using data from all US utilities", Energy Economics, vol. 60 (November 2016), pp. 122-130, https://www.sciencedirect.com/science/article/pii/S0140988316302353.
- 14 Deloitte, op. cit. note 13.
- 15 Ofgem, Household Consumer Perceptions of the Energy Market (London: 2020), https://www.ofgem.gov.uk/system/files/docs/2020/09/ consumer_perceptions_of_the_energy_market_q2_2020_pdf_1.pdf.
- 16 World Resources Institute, "Utility green tariffs", https://www.wri. org/our-work/project/clean-energy/utility-green-tariffs, viewed 23 December 2020.
- M. S. Barry and A. Creti, "Pay-as-you-go contracts for electricity access: Bridging the 'last mile' gap? A case study in Benin", Energy Economics, vol. 90 (August 2020), p. 104843, https://www.sciencedirect.com/ science/article/pii/S0140988320301833?via%3Dihub.
- Sidebar 7 from the following sources: M. Mazengarb, "Power Ledger partners with French utility to certify renewables with blockchain", One Step Off the Grid, 8 April 2020, https://onestepoffthegrid.com.au/power-ledger-partners-with-french-utility-to-certify-renewables-with-blockchain; Brooklyn Energy, "Brooklyn Microgrid", https://www.brooklyn.energy, viewed 16 December 2020; AsiaOne, "Senoko Energy, Electrify and Engie Factory team up to launch Singapore's first pilot project in peer-to-peer renewable trading", 21 July 2020, https://www.asiaone.com/business/senoko-energy-electrify-and-engie-factory-team-launch-singapore%E2%80%99s-first-pilot-project-peer; P. Maloney,

- "Green Mountain Power, LO3 pilot utilizes blockchain", American Public Power Association, 27 November 2019, https://www. publicpower.org/periodical/article/green-mountain-power-lo3-pilotutilizes-blockchain; P. Largue, "Indian electricity distributor to trial P2P solar trading", Power Engineering International, 16 November 2020, https://www.powerengineeringint.com/digitalization/indianelectricity-distributor-to-trial-p2p-solar-trading; Smart Energy International, "Bringing blockchain to India's power consumers", 3 April 2020, https://www.smart-energy.com/industry-sectors/ policy-regulation/bringing-blockchain-to-indias-power-consumers; EIA University, "Could Colombia Lead the Peer-to-Peer Energy Revolution?" (Medellin: 2020), http://www.transactive-energy. co/wp-content/uploads/2020/01/PolicyBriefingP2P_Colombia. pdf; The European Consumer Organisation (BEUC), The Future of Energy Consumers: Bright or Burdensome? (Brussels: 2019), https:// www.beuc.eu/publications/beuc-x-2019-055_the_future_of_ energy_consumers.pdf; International Renewable Energy Agency (IRENA), Innovation Landscape Brief: Net Billing Schemes (Abu Dhabi: 2019), https://www.irena.org/-/media/Files/IRENA/Agency/ Publication/2019/Feb/IRENA_Net_billing_2019.pdf.
- 19 C. Zhang et al., "Review of existing peer-to-peer energy trading projects", Energy Procedia, vol. 105 (May 2017), pp. 2563-68, https://www.sciencedirect.com/science/article/pii/S1876610217308007; F. Huneke and S. Nitzsche, Impulspapier Energy Sharing (Berlin: Energy Brainpool, June 2020), https://publikationen.windindustrie-in-deutschland.de/impulspapier-energy-sharing/63148775.
- 20 S. Liccardo and S. Kuehl, "California's three big utility companies stand in the way of consumer choice", San Francisco Chronicle, 1 September 2020, https://www.sfchronicle.com/opinion/openforum/ article/California-s-three-big-utility-companies-stand-15528929.php.
- 21 M. J. Kotchen, Climate Policy and Voluntary Initiatives: An Evaluation of the Connecticut Clean Energy Communities Program (Cambridge, MA: National Bureau of Economic Research, 2020), https:// environment.yale.edu/kotchen/pubs/CCEC.pdf.
- 22 S. MacDonald and N. Eyre, "An international review of markets for voluntary green electricity tariffs", Renewable and Sustainable Energy Reviews, vol. 91 (August 2018), pp. 180-92, https://www.sciencedirect. com/science/article/abs/pii/S1364032118301084?via%3Dihub.
- 23 K. Trumbull, J. Gattaciecca and J. R. DeShazo, The Role of Community Choice Aggregators in Advancing Clean Energy Transitions: Lessons from California (Los Angeles: UCLA Luskin Center for Innovation, 2020), https://innovation.luskin.ucla.edu/wp-content/uploads/2020/11/The_Role_of_CCAs_in_Advancing_Clean_Energy_Transitions.pdf; I. Todorović, "Electricity consumers in Turkey to get renewables-only tariff option", Balkan Green Energy News, 8 July 2020, https://balkangreenenergynews.com/electricity-consumers-in-turkey-to-get-renewables-only-tariff-option.
- 24 Deloitte, op. cit. note 13.
- R. Wait, "All you need to know about green energy tariffs", Forbes, 6 November 2020, https://www.forbes.com/sites/advisoruk/2020/ 05/15/all-you-need-to-know-about-green-energy-tariffs.
- 26 IRENA, Innovation Landscape Brief: Pay-as-you-go Models (Abu Dhabi: 2020), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jul/IRENA_Pay-as-you-go_models_2020.pdf.
- 27 Ibid
- 28 Empresas Públicas de Medellín, "Servicio de Energía Prepago", https://www.epm.com.co/site/clientes_usuarios/clientes-y-usuarios/hogares-y-personas/energia/tramites/energia-prepago, viewed 10 January 2021.
- 29 Renewable Energy Policy Network for the 21st Century (REN21), Renewables 2020 Global Status Report (Paris: 2020), www.ren21.net/gsr.
- 30 T. Couture et al., Residential Prosumers: Drivers and Policy Options (RE-Prosumers) (Paris: International Energy Agency, Renewable Energy Technology Deployment, 2014), https://www.osti.gov/ servlets/purl/1163237.
- 31 P. Pavanelli, *Pesquisa de Opinião Pública: Energia Elétrica* (Brasilia: Abraceel, 2020), https://abraceel.com.br/wp-content/uploads/post/2020/08/JOB-20_0211_Energia-El%C3%A9trica_2020_Abraceel-Apresenta%C3%A7%C3%A3o-2.pdf.
- 32 S. Hall and D. Brown, Business Models for Prosumers in Europe, Deliverable 4.1 of the Horizon 2020 PROSEU project (Brussels: 2020), https://www.researchgate.net/profile/Donal_Brown/ publication/338595423_Business_Models_for_Prosumers_in_ Europe/links/5e6b890aa6fdccf321d99717/Business-Models-for-Prosumers-in-Europe.pdf.

- 33 Ciudad Solar, "Estrategia de sustentabilidad", presentation, https://ciudadsolar.cdmx.gob.mx/storage/app/media/ presentacion-ciudad-solar.pdf, viewed 10 January 2021.
- 34 A. Hobbs et al., *Improving Solar Policy: Lessons from the Solar Leasing Boom in California* (San Francisco: Climate Policy Initiative, July 2013), https://www.climatepolicyinitiative.org/publication/improving-solar-policy-lessons-from-the-solar-leasing-boom-in-california.
- 35 HES Solar, "The evolution of solar leasing", 1 September 2016, https://www.hessolar.com/blog/2016/september/the-evolution-of-solar-leasing; S. Bajaj, "Kerala set to develop 200 MW of rooftop solar projects under Soura Program", Mercom India, 9 September 2019, https://mercomindia.com/kerala-soura-program-200mw-solar; T. Z. Yun, "Solutions: Getting financing for your solar power system", The Edge Markets, 22 January 2020, https://www.theedgemarkets.com/article/solutions-getting-financing-your-solar-power-system.
- 36 S. Hanley, "Western Australia trials Tesla PowerBank community storage system", CleanTechnica, 26 July 2019, https:// cleantechnica.com/2018/11/06/western-australia-trials-teslapowerbank-community-storage-system.
- 37 G. Walker and P. Devine-Wright, "Community renewable energy: What should it mean?", Energy Policy, vol. 36, no. 2 (2008), pp. 497-500, https:// www.sciencedirect.com/science/article/abs/pii/S0301421507004739.
- 38 A. L. Berka and E. Creamer, "Taking stock of the local impacts of community owned renewable energy: A review and research agenda", Renewable and Sustainable Energy Reviews, vol. 82, Part 3 (February 2018), pp. 3400-19, https://www.sciencedirect.com/science/article/abs/pii/S1364032117314247.
- 39 Islar and Busch, op. cit. note 6.
- 40 K. Szulecki, "Conceptualizing energy democracy", Environmental Politics, vol. 27, no. 1 (2018), pp. 21-41, https://www.tandfonline. com/doi/abs/10.1080/09644016.2017.1387294.
- 41 See, for example, the following: German Cooperation, "2nd Thai-German Community-based Renewable Energy Conference 2016", https://www.thai-german-cooperation.info/en_US/2nd-thai-german-community-based-renewable-energy-conference-2016; The Beam, "The community power movement is on the rise in Japan", Medium, 13 February 2017, https://medium.com/thebeammagazine/community-power-gears-up-global-renewable-energy-movement-dccbc184fea6; Community Energy Association Canada, "About us", https://www.communityenergy.ca/about-us, viewed 8 January 2021. See also examples cited throughout this chapter.
- 42 A. Bolle, How Cities Can Back Renewable Energy Communities (Brussels: Energy Cities, 2019), https://energy-cities.eu/ publication/how-cities-can-back-renewable-energy-communities.
- 43 European Committee of the Regions, Models of Local Energy Ownership and the Role of Local Energy Communities in Energy Transition in Europe (Brussels: 2018), https://cor.europa.eu/en/engage/studies/Documents/local-energy-ownership.pdf.
- 44 Haf and Robison, op. cit. note 7.
- 45 Bolle, op. cit. note 42.
- 46 Ibid.
- 47 Ibid.
- 48 REScoop, "Council finalizes Clean Energy for All Europeans Package, empowering citizens energy communities", 23 May 2019, https://www.rescoop.eu/news-and-events/press/council-finalises-clean-energy-for-all-europeans-package-empowering-citizens-energy-communities.
- 49 G. Willmer, "Homemade energy gets boost to go mainstream", Horizon, 6 May 2019, https://horizon-magazine.eu/article/homemade-energy-gets-boost-go-mainstream.html.
- 50 REScoop, https://www.rescoop.eu, viewed 7 January 2021.
- 51 A. Caramizaru and A. Uihlein, Energy Communities: An Overview of Energy and Social Innovation (Luxembourg: European Commission, 2020), https://publications.jrc.ec.europa.eu/repository/bitstream/ JRC119433/energy_communities_report_final.pdf.
- 52 C. Pons-Seres de Brauwer and J. J. Cohen, "Analysing the potential of citizen-financed community renewable energy to drive Europe's low-carbon energy transition", Renewable and Sustainable Energy Reviews, vol. 133 (November 2020), p. 110300, https://www. sciencedirect.com/science/article/pii/S1364032120305888.
- 53 Cooperatives Europe, The COVID-19 Crisis and Its Economic and Social Impact on Cooperatives Across Europe (Brussels: 2020), https://coopseurope.coop/sites/default/files/Covid19%20 Report_CoopsEurope-compressed.pdf.

- 54 E. Barbiroglio, "1,000 solar roofs boost recovery and citizen engagement in Croatia", Forbes, 4 August 2020, https://www.forbes.com/sites/emanuelabarbiroglio/2020/08/04/1000-solar-roofs-boost-recovery-and-citizen-engagement-in-croatia.
- 55 Som Energia, "La Cooperativa D'Energia Verda", https:// www.somenergia.coop, viewed 9 November 2020; Goiener, S. Coop. "Goiener Taldea: Empowering citizens through energy", Transformative Cities, 3 September 2020, https:// transformativecities.org/atlas/atlas-034.
- 56 A. G. Valdivia, "Renewable energy in Spain: From the 'Sun Tax' to the promotion of collective self-consumption", Forbes, 15 April 2019, https://www.forbes.com/sites/anagarciavaldivia/2019/04/15/ renewable-energy-in-spain-from-the-sun-tax-to-the-promotion-of-collective-self-consumption; P. S. Molina, "Spain's new rules for self-consumption come into force", pv magazine, 8 April 2019, https://www.pv-magazine.com/2019/04/08/ spains-new-rules-for-self-consumption-come-into-force.
- Resilience, "Girona, Spain: Cooperative breaks the mould to provide renewable energy", 25 September 2018, https://www.resilience.org/stories/2018-09-25/girona-spain-cooperative-breaks-the-mould-to-provide-renewable-energy; Energy Cities, "Community energy from scratch", https://energy-cities.eu/inspiring-mind/community-energy-from-scratch, viewed 18 January 2021; Energy Democracy, "Energética Cooperative challenges energy poverty by supplying clean energy", 21 December 2020, https://energy-democracy.net/energetica-cooperative-challenges-energy-poverty-by-supplying-clean-energy.
- 58 Caramizaru and Uihlein, op. cit. note 51; World Wind Energy Association (WWEA), "German government clearly misses all three self-imposed goals associated with auctions", 2 September 2019, https://wwindea.org/blog/2019/09/02/german-government-clearly-misses-all-three-self-imposed-goals-associated-with-auctions; Deutscher Genossenschafts- und Raiffeisenverband e.V., Energy Cooperatives in Germany. State of the Sector Report 2020 (Berlin: 2020), https://www.dgrv.de/wp-content/uploads/2020/07/20200708_State-of-the-sector-2020.pdf.
- 59 WWEA op. cit. note 58; Deutscher Genossenschafts- und Raiffeisenverband e.V., op. cit. note 58.
- 60 Agentur für Erneuerbare Energien e.V. 2020, Energiegenossenschaften im Auf- und Abschwung (Berlin: 2020) https://www.unendlich-viel-energie.de/media/file/4051.AEE_RK_ Energiegenossenschaften_jul20.pdf.
- 61 Agentur für Erneuerbare Energien e.V., Community Energy in Germany (Berlin: 2019), https://www.unendlich-viel-energie.de/media/file/3591.89_Renews_Spezial_Community_energy_LECo.pdf.
- 62 Bürgerenergie Jena, https://www.buergerenergie-jena.de, viewed 18 January 2021.
- B. Epp and M. Oropeza, eds., Solar Heat for Cities: The Sustainable Solution for District Heating (Paris: International Energy Agency Solar Heating & Cooling Programme, 2019), https://www.solarthermalworld.org/sites/default/files/news/file/2019-12-19/solar_heat_for_cities_screen_optimised_task_55_iea_shc_november_2019.pdf; Plan Energi, "One GW solar heating in Denmark", https://planenergi.eu/activities/district-heating/solar-district-heating/1-gw-sdh-in-dk, viewed 21 December 2020; Co2mmunity, "Community energy cases", http://co2mmunity.eu/outputs/community-energy-cases, viewed 9 November 2020.
- 64 Epp and Oropeza, eds., op. cit. note 63; Co2mmunity, op. cit. note 63.
- 65 S. Robinson and D. Stephen, Community Energy: State of the Sector 2020 (Sheffield: 2020), https://communityenergyengland. org/files/document/385/1592215769_CommunityEnergy-StateoftheSector2020Report.pdf.
- 66 Ibid.
- 67 Ibid.
- 68 Community Energy London, https://www.communityenergy.london, viewed 18 January 2021.
- 69 Edinburgh Community Solar Co-operative, https://www. edinburghsolar.coop, viewed 31 December 2020.
- 70 Brighton Energy Cooperative, https://brightonenergy.org.uk, viewed 8 January 2021; Sustainable Dorset, "Community Energy Team Dorset Energy Council", https://www.sustainabledorset.org/item/community-energy-team-dorset-county-council, viewed 8 January 2021; Bristol Energy Cooperative, http://bristolenergy.coop/about/, viewed 8 January 2021; Cardiff Community Energy, http://www.cardiffcommunityenergy.co.uk, viewed 8 January 2021.

- 71 REScoop, "The LICHT Approach", 19 October 2020, https://www.rescoop.eu/toolbox/the-licht-approach.
- 72 Hageland Stroomt, "Piloot Project", https://hagelandstroomt.be/ wat-doen-we/pilootprojec, viewed 9 November 2020.
- 73 Noordlicht, "Zonnepanelen Op Kinderkribbe Jannemieke in Zaventem Officieel in Gebruik Genomen", 7 October 2020, https:// www.noordlicht.be/nieuws/nieuws-nieuws/zonnepanelenkinderkribbe-zaventem-in-gebruik.html; A. Dimitrova, "A large cooperative project on renewable energy starts in Leuven", The Mayor, 15July 2020, https://www.themayor.eu/en/a/view/a-largecooperative-project-on-renewable-energy-starts-in-leuven-5388.
- 74 Covenant of Mayors, Database, https://www.eumayors.eu/ support/library.html, viewed 23 December 2020.
- 75 Carbon Co-op, "Our visit to EcoPower, the brilliant Belgian energy coop", 15 September 2016, https://carbon.coop/2016/09/our-visit-to-ecopower-the-brilliant-belgian-energy-coop; Ecopower, "Eeklo 2 Wind", https://www.ecopower.be/over-ecopower/productie-installaties/eeklo-2, viewed 23 December 2020.
- 76 Pajopower, "Adopteer je straatlamp: investeren in duurzame energie in Halle", https://www.pajopower.be/projecten/adopteer-je-energiezuinige-led-lamp, viewed 23 December 2020.
- 77 Windpark Zeewolde, "What is Zeewolde Wind Park?" https://windparkzeewolde.nl/wat-is-windpark-zeewolde, viewed 9 November 2020.
- 78 S. Giovannini, "Slavutych, Ukraine The community energy story you need to hear!", Energy Cities, 10 December 2019, https://energy-cities.eu/slavutych-ukraine-the-communityenergy-story-you-need-to-hear.
- 79 Friends of the Earth Europe, REScoop.eu and Energy Cities, Community Energy. A Practical Guide to Reclaiming Power (Brussels: October 2020), https://energy-cities.eu/wp-content/uploads/2020/10/13-FoEE-Community-Energy-Guide-mr.pdf.
- 80 EnCES Citizen Energy of the Eurometropolis, https://www.brasseursdenergie.eu, viewed 31 December 2020.
- 81 J. Heeter, "Sharing the Sun Community Solar Project Data" (Golden, CO: National Renewable Energy Laboratory, May 2020), https://data.nrel.gov/submissions/131.
- 82 Ibid
- 83 City of Portland, "About PCEF", https://www.portland.gov/bps/cleanenergy/about, viewed 23 December 2020.
- 84 S. Furuya, "The community power movement is on the rise in Japan", The Beam, 13 February 2017, https://medium.com/thebeammagazine/community-power-gears-up-global-renewable-energy-movement-dccbc184fea6.
- 85 Y. H. Kang and L. Joubert, "Grassroots solar energy in South Korea", Energy Transition, 27 September 2018, https://energytransition.org/ 2018/09/south-koreas-grassroots-energy-transition.
- 86 Heeter, op. cit. note 81.
- 87 Ibid
- 88 Kang and Joubert, op. cit. note 85; H. Kim, "A community energy transition model for urban areas: The energy self-reliant village program in Seoul, South Korea", Sustainability, vol. 9, no. 7 (2017), https://www.mdpi.com/2071-1050/9/7/1260.
- 89 Inter-American Development Bank, Latin American Energy Organization (OLADE) and Energy Technology Working Group, Energy Access and Affordability Voluntary Action Plan for Latin America and the Caribbean (Washington, DC: 2018), http://biblioteca.olade.org/opac-tmpl/Documentos/old0418.pdf.
- 90 Red Girasol, "Empresa Dedicada Al Crowdfunding De Proyectos De Energía Solar Para Hogares", https://www.redgirasol.com, viewed 9 November 2020.
- 91 K. Schneider et al., "Shared solar cooperatives in Brazil: Context, overcoming barriers and lessons to be drawn from previous European countries experiences", paper presented at 36th EU PVSEC European Photovoltaic Solar Energy Conference and Exhibition, Marseille, France, September 2019, https://www.researchgate.net/publication/335989100_SHARED_SOLAR_COOPERATIVES_IN_BRAZIL_CONTEXT_OVERCOMING_BARRIERS_AND_LESSONS_TO_BE_DRAWN_FROM_PREVIOUS_EUROPEAN_COUNTRIES_EXPERIENCES.
- 92 E. Araujo, "Brasil terá primeira cooperativa de energia solar em favela do RJ", Canal Solar, 18 June 2020, https://canalsolar. com.br/noticias/item/616-brasil-tera-primeira-cooperativa-de-energia-solar-em-favela-do-rj.

- 93 Department of Environment, Land, Water and Planning of Victoria State, "Community energy", https://www.energy.vic.gov.au/renewable-energy/community-energy, viewed 9 November 2020.
- 94 S. Vorrath, "Australia's biggest 'solar garden' opens for membership in NSW Riverina", One Step Off the Grid, 17 September 2020, https://onestepoffthegrid.com.au/australias-biggest-solar-garden-opens-for-membership-in-nsw-riverina.
- 95 Totally Renewable Yackandandah, https://totallyrenewableyack.org. au, viewed 23 December 2020; G. Parkinson, "Yackandandah takes another step closer to 100% renewable energy", RenewEconomy, 3 October 2019, https://reneweconomy.com.au/yackandandahtakes-another-step-closer-to-100-renewable-energy-94764.
- 96 M. Mazengarb, "Independent MP launches \$483m local power plan to boost community energy", One Step Off the Grid, 23 September 2020, https://onestepoffthegrid.com.au/independent-mplaunches-483m-local-power-plan-to-boost-community-energy.
- 97 African Development Forum, Electricity Access in Sub-Saharan Africa (Washington, DC: 2019), https://openknowledge.worldbank. org/bitstream/handle/10986/31333/9781464813610.pdf.
- 98 World Bank, "Lighting up Africa: Bringing renewable, off-grid energy to communities", 13 August 2020, https://www.worldbank.org/en/news/feature/2020/08/13/lighting-up-africa-bringing-renewable-off-grid-energy-to-communities.
- 99 Sun Exchange, "Crowd Sale: Own and Earn", presentation, https://d1tsx6lhcafpu4.cloudfront.net/production/6f499ca7b629 406e9a7c571c02eabba5.pdf, viewed 23 December 2020.
- Energy Cities, Guidelines for Local and Regional Policy Makers (Brussels: 2019), https://energy-cities.eu/wp-content/uploads/ 2019/06/EnergyCities_RNP_Guidebook_Web.pdf. City Snapshot: Jakarta based on the following sources: Energy Cities, op. cit. this note; ICLEI-Local Governments for Sustainability, "City Profile: National Capital Region of Jakarta (Indonesia)", 12 December 2017, https://acp.iclei.org/wp-content/uploads/2019/10/ Jakarta-profile.pdf; CDP, "2018-2019 City-Wide Emissions", CDP Open Data Portal, https://data.cdp.net/Emissions/2018-2019-City-wide-Emissions/mkj4-km9s; Provincial Government of DKI Jakarta, "Regional Medium-Term Development Plan (RPJMD) of DKI Jakarta 2017-2022", 16 April 2018, https://bappeda.jakarta. go.id/uploads/document/2019-07-17/65/65__RPJMD_2017-2022. pdf; ICLEI Indonesia, "DKI Jakarta stakeholders prioritize low emission development options for implementation", 13 December 2019, https://icleiseas.org/index.php/2019/12/13/formulationworkshop-towards-ghg-emissions-reduction-in-jakarta; D. R. Meilanova, "6 Provinsi Telah Selesaikan Rancangan Umum Energi Daerah: Ekonomi", Bisnis.com, 27 March 2018, https:// ekonomi.bisnis.com/read/20180327/44/754937/6-provinsi-telahselesaikan-rancangan-umum-energi-daerah; Governor of Jakarta, "Instruction of The Governor of Jakarta 66/2019: Air Quality Control" (Jakarta: 2019), https://jdih.jakarta.go.id/uploads/default/ produkhukum/INGUB_NO._66_TAHUN_2019.pdf.
- 101 Based on examples cited throughout this chapter.
- 102 G. Nanrah, "Plans revealed for huge new solar farm in Notts", Nottinghamshire Live, 28 April 2020, https://www.nottinghampost. com/news/local-news/plans-revealed-huge-new-solar-4082868.
- 103 Edinburgh Talks Climate, https://edinburghtalksclimate.dialogueapp.com, viewed 9 November 2020.
- 104 Renewable Networking Platform, "Best Practice: Co-Designing Low Carbon Public Services", https://www.renewablesnetworking.eu/documents/Fl-li.pdf, viewed 9 November 2020.
- 105 Municipality of Ii, "Climate action and renewable energy", https://www.ii.fi/en/climate-actions-and-renewable-energy, viewed 18 January 2020.
- 106 Energy Cities, Local Energy and Climate Roadmaps (Brussels: 2018), https://energy-cities.eu/wp-content/uploads/2019/02/local_energy_climate_roadmaps_final-1.pdf.
- 107 Smart City EU, Roadmap 2025: 50 Steps Towards a Carbon Neutral Sonderborg (Brussels: 2020), https://smartencity.eu/ media/roadmap2025_eng.pdf.
- 108 A. Dimitrova, "Amsterdam becomes natural gas-free by 2040", The Mayor, 9 April 2020, https://www.themayor.eu/en/ amsterdam-becomes-natural-gas-free-by-2040.
- 109 Gent municipality, "#ALSGETMIJVRAAGT Dampoort", https:// stad.gent/nl/mobiliteit-openbare-werken/mobiliteit/plannenprojecten-subsidies-cijfers-scholenwerking/wijkmobiliteitsplan/ wijkmobiliteitsplan-dampoort, viewed 23 December 2020.

- 110 WSAV, "Savannah leaders, community members discuss shift to clean energy at town hall", 19 February 2020, https://www. newsbreak.com/georgia/savannah/news/1512139149211/ savannah-leaders-community-members-discuss-shift-to-clean-energy-at-town-hall?s=samsung_daily.
- 111 CalCCA, https://cal-cca.org, viewed 8 January 2021.
- 112 eThekwini Municipality, "Public encouraged to comment on Draft Energy Policy", 24 November 2020, http://www.durban.gov.za/ Resource_Centre/new2/Pages/Public-encouraged-to-commenton-Draft-Energy-Policy-.aspx.
- 113 Ibid
- 114 iShack, https://www.ishackproject.co.za, viewed 23 December 2020.
- 115 GreenCape, "Witsand Informal Settlement: Building resilient urban communities though innovation and partnership" (Cape Town: 2020), https://www.greencape.co.za/assets/GreenCape_Resilience_ Case_Study_Witsand_29_6_20.pdf.
- Y. Cabannes, "Participatory budgeting in Paris: Act, reflect, grow", in Y. Cabannes, ed., Another City Is Possible with Participatory Budgeting (Montreal/New York/London: Black Rose Books, 2017), pp. 179-203, https://budgetparticipatif.paris.fr/bp/plugins/download/PB_in_Paris.pdf.
- 117 Renewable Networking Platform, "Best Practice: Mouscron's Community Energy Model", https://www.renewables-networking. eu/documents/BE-Mouscron.pdf, viewed 9 November 2020.
- 118 A. Fortes, "Participatory budgeting in Porto Alegre: An experience in democratic innovation and its historical background", Moving the Social, vol. 49 (2013), pp. 113-32, https://moving-the-social. ub.rub.de/index.php/MTS/article/view/7518/6690.
- 119 Fridays for Future, "Strike statistics", https://fridaysforfuture.org/ what-we-do/strike-statistics, viewed 18 January 2021.
- 120 Lochem Energie, "Burger-Energiecoöperatie Lochem Energie", https://www.lochemenergie.net/je-eigen-energie, viewed 9 November 2020.
- 121 Friends of the Earth, "Communities fighting climate breakdown", https://friendsoftheearth.uk/climate/communities-fighting-climate-breakdown, viewed 23 December 2020; Climate Action Leicester and Leicestershire, http://www.climateactionleicesterandleicestershire.org.uk, viewed 23 December 2020.
- 122 Electridad, "AES Gener's Ventanas 1 thermoelectric plant in Puchuncaví will close in December", 28 October 2020, https://www.revistaei.cl/2020/10/28/en-diciembre-cerraratermoelectrica-ventanas-1-de-aes-gener-en-puchuncavi.
- 123 V. C. Broto and M. S. Calvet, "Sacrifice zones and the construction of urban energy landscapes in Concepción, Chile", Journal of Political Ecology, vol. 27, no. 1 (2020), pp. 279-99, https://www.researchgate.net/publication/340615212_Sacrifice_zones_and_the_construction_of_urban_energy_landscapes_in_Concepcion_Chile; Chile Sustentable, "Cierre de termoeléctricas: Región del Bío Bío sólo quedará con una central a carbón en 2022", 1 June 2020, http://www.chilesustentable.net/2020/06/cierre-de-termoelectricas-region-del-bio-bio-solo-quedara-conuna-central-a-carbon-en-2022.
- 124 S. Becker, M. Naumann and T. Moss, "Between coproduction and commons: Understanding initiatives to reclaim urban energy provision in Berlin and Hamburg", *Urban Research & Practice*, vol. 10, no. 1 (2017), pp. 63-85, https://www.tandfonline.com/doi/ abs/10.1080/17535069.2016.1156735.
- 125 H. Busch and K. McCormick, "Local power: Exploring the motivations of mayors and key success factors for local municipalities to go 100% renewable energy", Energy, Sustainability and Society, vol. 4, art. 5 (2020), https://link.springer.com/ article/10.1186/2192-0567-4-5; Energy Cities, op. cit. note 100.
- 126 Transnational Institute, "Public Futures. Global database of de-privatised public service", https://publicfutures.org, viewed 18 January 2021.
- 127 S. Kishimoto, L. Steinfort and O. Petitjean, The Future Is Public - Towards Public Ownership of Public Services (Amsterdam and Paris: New Europe, 2020), https://www.tni.org/files/publication-downloads/futureispublic_online_def.pdf.
- 128 Ibid
- 129 Eau de Paris, "Eau de Paris présente son plan climat énergie", 9 November 2016, http://www.eaudeparis. fr/nc/ac/lespace-culture/actualites/actualite/news/ eau-de-paris-presente-son-plan-climat-energie.

- 130 Renewables Networking Platform, "Best Practice: Active citizenship for Renewable Energy, Wolfhagen, Germany", https://www.renewables-networking.eu/documents/ DE-Wolfhagen.pdf, viewed 23 December 2020.
- 131 M. Bunn, "Robin Hood Energy hit with £9.5m green tax payment threat by Ofgem", Nottinghamshire Live, 1 October 2019, https://www.nottinghampost.com/news/nottingham-news/robin-hood-energy-threatened-losing-3379637; "Bristol Energy was 'wrong market', says city mayor", BBC News, 21 July 2020, https://www.bbc.com/news/uk-england-bristol-53485283.
- 132 Mpower, "A democratic transition to renewable energy in Cádiz", 2 June 2020, https://municipalpower.org/ articles/a-democratic-transition-to-renewable-energy-in-cadiz.
- 133 S. Burgen, "Renewable energy in Cádiz and Barcelona, Spain", AltEnergyMag, 30 May 2019, https://www.altenergymag.com/ article/2019/05/renewable-energy-in-c%C3%A1diz-andbarcelona-spain/31052.
- 134 D. Q. Ilkhani and E. Woertz, Remunicipalisation of Local Energy Provision: The Role of Cities and Bottom-up Initiatives (Barcelona: CIDOB, May 2019), https://www.cidob.org/en/publications/ publication_series/cidob_policy_brief/remunicipalisation_of_local_ energy_provision_the_role_of_cities_and_bottom_up_initiatives.
- (35) Climate Emergency Declaration, "Climate emergency declarations in 1,830 jurisdictions and local governments cover 820 million citizens", 5 November 2020, https://climateemergencydeclaration. org/climate-emergency-declarations-cover-15-million-citizens.
- 136 Cedamia, "Climate Emergency Declaration", https://www.cedamia.org/global, viewed 9 November 2020.
- 137 Climate Emergency Declaration, op. cit. note 135.
- 138 Ibid.
- 39 City Snapshot: Recife based on the following sources: CDP, "2018-2019 City-Wide Emissions", CDP Open Data Portal, https://data.cdp.net/Emissions/2018-2019-City-wide-Emissions/mkj4-km9s; ICLEI, "Recife becomes first Brazilian city to declare climate emergency", 20 November 2019, https://iclei.org/en/media/recife-becomes-first-brazilian-city-to-declare-climate-emergency; CELPE, "O Futuroa Gente Faz Agora", https://servicos.celpe.com.br/a-celpe/Paginas/Efici%C3%AAncia%20 Energ%C3%A9tica/Como-participar-EE.aspx; ANEEL, "Programa De Eficiência Energética ANEEL", https://www.aneel.gov.br/programa-eficiencia-energetica, viewed 5 January 2021.
- 140 Climate Emergency Declaration, op. cit. note 135.
- 141 Ibid.
- 142 Ibid.
- 143 Ibid.; REN21 Policy Database (2020), available at www.ren21.net/cities/datapack. Data are compiled by REN21 and based on CDP-ICLEI Unified Reporting System, CDP Open Data, The Global 100% Renewable Energy Platform, Climate Action Network, C40, ICLEI, IRENA, Sierra Club, UK100 and REN21 data collection. Some research is based on voluntary reporting and therefore may not be exhaustive.
- 144 Climate Emergency Declaration, op. cit. note 135. Figure 17 from REN21 op. cit. note 143. Data are compiled by REN21 and based on CDP-ICLEI Unified Reporting System, CDP Open Data, The Global 100% Renewable Energy Platform, Climate Action Network, C40, ICLEI, IRENA, Sierra Club, UK100 and REN21 data collection. Some research is based on voluntary reporting and therefore may not be exhaustive.
- 145 Ibid.

FEATURE

- 1 World Bank, "Population total Sub-Saharan Africa", https://data. worldbank.org/indicator/SP.POP.TOTL?locations=ZG, viewed 30 October 2020; United Nations (UN), World Urbanization Prospects, Volume 12 (New York: 2018), https://population.un.org/wup.
- World Bank, Poverty and Shared Prosperity 2018: Piecing Together the Poverty Puzzle (Washington, DC: 2018), https://www.worldbank. org/en/publication/poverty-and-shared-prosperity-2018.
- 3 Ibid
- 4 UN, op. cit. note 1.
- International Energy Agency (IEA), Africa Energy Outlook 2019 Analysis Scenarios, World Energy Outlook Special Report (Paris: 2019), p. 288, https://www.iea.org/reports/africa-energy-outlook-2019.
- 6 Ibid., p. 288; IEA, World Energy Outlook 2020 (Paris: 2020), https://www.iea.org/reports/world-energy-outlook-2020.
- 7 IEA, World Energy Outlook 2020, op. cit. note 6, IEA, op. cit. note 5, p. 288.
- 8 International Renewable Energy Agency (IRENA), Global Renewables Outlook: Energy Transformation 2050 (Abu Dhabi: 2020), https:// www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Apr/ IRENA_Global_Renewables_Outlook_2020.pdf.
- 9 IRENA, Renewable Energy in National Climate Action (Abu Dhabi: 2018), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Dec/IRENA_COP24_NDC_update_2018.pdf.
- IRENA, Scaling Up Renewable Energy Deployment in Africa: Impact of IRENA's Engagement (Abu Dhabi: 2019), https://www.irena.org/cleanenergycorridors/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Africa_impact_2019.ashx; Z. Gebrehiwot, "The EAPP Master Plan and Renewable Energy Options", presentation at Executive Strategy Workshop to Map Out Priorities for IRENA's Africa Clean Energy Corridor Initiative, Abu Dhabi, 22-23 June 2013, https://www.irena.org/-/media/Files/IRENA/Agency/Events/2013/Nov/9_1/Afriac-CEC-session-2_EAPP_Gebrehiwot_220613.pdf; IRENA, op. cit. note 9.
- 11 L. Tait and M. Euston-Brown, "What role can African cities play in low-carbon development? A multilevel governance perspective of Ghana, Uganda and South Africa", Journal of Energy in Southern Africa, vol. 28, no. 3 (2017), pp. 43-53, http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1021-447X2017000300004; S. Bawakyillenuo et al., "Sustainable energy transitions in Sub-Saharan African cities: The role of local government", Urban Energy Transition (2018), pp. 529-51, https://www.sciencedirect.com/science/article/pii/B9780081020746000425.
- 12 Covenant of Mayors in Sub-Saharan Africa (CoM SSA), "About", 2015, https://comssa.org/about; C40 Cities, "Climate Action Planning (CAP) Africa launch event and 1st Regional Academy", 15 May 2018, https://www.c40.org/tags/cap-africa.
- 13 ESI Africa, "The big question: The future skyline of energy generation in cities", 11 May 2020, https://www.esi-africa.com/industry-sectors/future-energy/the-big-question-the-future-skyline-of-energy-generation-in-cities.
- 14 Ibid.
- 15 Ibid.
- 16 CoM SSA, op. cit. note 12; Supporting African Municipalities in Sustainable Energy Transitions (SAMSET), https://samsetproject.net, 2014.
- 17 Figure 18 from the following sources: Sustainable Energy Africa (SEA), State of Energy in South African Cities Report 2020 (Cape Town: 2020), http://www.cityenergy.org.za/uploads/resource_508.pdf; J.N. Yongoua, S. Sambou and L. Nicholson, Rapport d'inventaire Des Émissions de Gaz à Effet de Serre de La Ville de Dakar, 2016 (Dakar: C40 Cities, 2019); SEA, Data and Scenario Modelling Technical Report for Kampala, Uganda (Kampala: 2019); SEA, Rapport Technique Sur La Modélisation Des Scénarios Pour La Commune d'Arrondissement de Yaoundé IV, Cameroun (Yaoundé: 2019); SEA, Data and Scenario Modelling Technical Report, Tsévié City, Togo (Tsévié City 2019).
- 18 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 19 Ibid.
- 20 IEA, op. cit. note 5, p. 288; A.K. Amegah and S. Agyei-Mensah, "Urban air pollution in Sub-Saharan Africa: Time for action", Environmental Pollution, vol. 220, part A (January 2017), pp. 738-43, https://www.sciencedirect.com/science/article/abs/pii/S02697 49116312933.

- 21 SEA, Data and Scenario Modelling Technical Report, Tsévié City, Togo, op. cit. note 17.
- 22 IEA, op. cit. note 5, p. 288.
 - Figure 19 from the following sources: SEA, State of Energy in South African Cities Report 2020, op. cit. note 17; Yongoua, Sambou and Nicholson, op. cit. note 17; SEA, Data and Scenario Modelling Technical Report for Kampala, Uganda, op. cit. note 17; SEA, Rapport Technique Sur La Modélisation Des Scénarios Pour La Commune d'Arrondissement de Yaoundé IV, Cameroun, op. cit. note 17; SEA, Data and Scenario Modelling Technical Report, Tsévié City, Togo, op. cit. note 17.
- 24 Western Cape Government, 2017 Socio-economic Profile: City of Cape Town (Cape Town, South Africa: 2017), https://www.westerncape.gov.za/assets/departments/treasury/Documents/Socio-economic-profiles/2017/city_of_cape_town_2017_socio-economic_profile_sep-lg_-_26_january_2018.pdf.
- 25 Ibid
- 26 Department of Energy of the Republic of South Africa, The South African Energy Sector Report 2019 (Pretoria: 2019), http://www. energy.gov.za/files/media/explained/2019-South-African-Energy-Sector-Report.pdf.
- 27 Department of Mineral Resources and Energy of the Republic of South Africa, *Integrated Resource Plan* (IRP 2019) (Pretoria: 2019), http://www.energy.gov.za/IRP/2019/IRP-2019.pdf.
- 28 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 29 Ibid.
- 30 Ibid.
- 31 SEA and City of Cape Town, Cape Town State of Energy 2015 Report (Cape Town: 2015), https://africancityenergy.org/uploads/resource_22.pdf.
- 32 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 33 Ibid.
- 34 Ibid
- 35 Cape Town's local sustainable energy approach mirrored that of the national Energy White Paper of 1998, with a strong emphasis on energy poverty, environmental protection (including climate mitigation) and energy security towards much-needed economic development. This early work was located within the Environmental Resources Management Department, and the City employed a single Energy Officer in 2006. This grew to a fully established and staffed Energy and Climate Change Unit over the next 10 years and was given impetus by the inclusion of the energy and climate goals in the Integrated Development Plan from as early as 2008. SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 36 SEED, a 13-year, award-winning capacity-building programme born at the time of the democratic transition in South Africa, became the genesis of the country's local energy movement. SEED was designed to help the government tackle the urban crisis from an energy perspective, through fostering individuals and programmes and growing the critical skills to plan and manage energy. The first State of Energy in South African Cities report was produced under this programme. From SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 37 SEA and City of Cape Town, op. cit. note 31.
- 38 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 39 Ibid.
- 40 City of Cape Town, "Rooftop PV: Guidelines for safe and legal installations in Cape Town" (Cape Town: 2018), https://www.westerncape.gov.za/energy-security-game-changer/files/atoms/files/Energy-PV-Brochure.pdf.
- 41 South African Local Government Association (SALGA), Status of Small Scale Embedded Generation in South African Municipalities (Pretoria: 2020), p. 13, https://www.sseg.org.za/status-of-sseg-2020.
- 42 Ibid
- 43 This was achieved through initiatives such as the GIZ South African-German Energy Programme (GIZ SAGEN) Municipal Sustainable Energy Transition Support Programme, which aims to promote sustainable energy in municipalities, with a focus on renewables and energy efficiency. SEA, State of Energy in South African Cities 2020, op. cit. note 17, pp. 67-69.

- 44 Between 2008 and 2010, the City of Cape Town implemented two major solar water heater roll-out programmes in low-income households, both of which were grant-funded, in the communities of Kuyasa (2,000 units) and Joe Slovo (1,500 units). SEA and City of Cape Town, op. cit. note 31; GIZ-SAGEN and SEA, Review of Best Practice Solar Water Heating Implementation by Local Government (Pretoria: GIZ, 2015), http://www.cityenergy.org.za/ uploads/resource_351.pdf.
- 45 SEA, Sustainable Energy Solutions for South African Local Government: A Practical Guide (Cape Town: 2017), pp. 38-40, http://www.cityenergy.org.za/uploads/resource_434.pdf.
- 46 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 47 SEA and City of Cape Town, op. cit. note 31.
- 48 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 49 Ibid.
- Business Insider South Africa, "Big breakthrough: Some municipalities can now generate their own electricity",
 16 October 2020, https://www.businessinsider.co.za/some-municipalities-can-procure-their-own-electricity-2020-10.
- 51 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 52 Ibid.
- 53 City of Cape Town, *Draft City of Cape Town Climate Change Strategy* (Cape Town: 2020), http://www.capetown.gov.za/councilonline/_layouts/OpenDocument/OpenDocument.aspx? DocumentId=509d02cf-c744-4aba-b913-6fc05e2dfeea.
- 54 Ibio
- 55 This plan is further broken down in sectoral plans such as the Comprehensive Integrated Transport Plan, the Cape Town Metropolitan Spatial Development Framework, and the Cape Town Energy and Climate Change Strategy, among others. City of Cape Town, Comprehensive Integrated Transport Plan 2018-2023 (Cape Town: 2018) https://tdacontenthubstore.blob.core.windows.net/resources/fd3ddc0d-b459-4d26-bb01-7f689d7a36eb.pdf.
- 56 Ibid
- 57 Urban Electric Mobility Initiative, *Cape Town EV Readiness*Assessment (Cape Town: 2018), http://www.uemi.net/
 uploads/4/8/9/5/48950199/ev_r_sa.pdf.
- 58 City of Cape Town, City of Cape Town EV Framework (Cape Town: 2019), http://www.cityenergy.org.za/uploads/resource_471.pdf.
- 59 Ibid. The renewable energy can be purchased through a renewable energy certificate or directly from a renewable energy IPP and wheeled through the grid. Wheeling is the term for the transport of electric energy from within an electrical grid from one party (the seller) to another party (the buyer). Wheeling deals with the use of the network and the cost of delivering the energy.
- 60 Yongoua, Sambou and Nicholson, op. cit. note 17.
- 61 100 Resilient Cities, Dakar Resilient Strategy (Dakar: 2016), https://resilientcitiesnetwork.org/networks/dakar.
- 62 Power Africa, "Senegal Power Africa Fact Sheet" (Washington, DC: US Agency for International Development, 2020), https://www.usaid.gov/powerafrica/senegal.
- 63 Ministry of Petroleum and Energy of the Republic of Senegal, "Lettre de Politique de Développement du Secteur de l'Energie" (Dakar: 2012).
- 64 Republic of Senegal, Plan Sénégal Emergent (Dakar: 2014), https://www.sec.gouv.sn/sites/default/files/Plan%20 Senegal%20Emergent_0.pdf.
- Ministry of Urban Renewal, Housing and the Living Environment of the Republic of Senegal, Plan Directeur d'Urbanisme de Dakar et ses Environs Horizon 2035 (Dakar: 2016), http://www.pdudakar. gouv.sn/IMG/pdf/eijr16003_da2875.pdf.
- 66 City of Dakar, personal communication with SEA, November 2020.
- 67 Ibid.
- 68 Yongoua, Sambou and Nicholson, op. cit. note 17.
- 69 Ibid.; US Energy Information Administration, "How much electricity does an American home use?" https://www.eia.gov/tools/faqs/faq.php?id=97, viewed 27 September 2020.
- 70 Yongoua, Sambou and Nicholson, op. cit. note 17.

- 71 National Agency of Statistics and Demography of the Republic of Senegal, Situation Economique et Sociale de la Région de Dakar, 2016 edition (Dakar: 2019), http://www.ansd.sn/ressources/ses/SES-Dakar-2016.pdf.
- 72 Ibid
- 73 Executive Council of Urban Transport in Dakar (CETUD), Plan de Déplacements Urbains de Dakar (PDUD), 2008-2025 (Dakar: 2008).
- 74 City of Dakar, Atelier de plannification climat (Dakar: November 2019).
- 75 Uganda Bureau of Statistics, *The National Population* and Housing Census 2014 Area Specific Profile Series (Kampala: 2017), https://www.ubos.org/wp-content/uploads/publications/2014CensusProfiles/KAMPALA-KCCA.pdf.
- 76 Kampala Capital City Authority (KCCA), Energy and Climate Profile (Kampala: 2016), https://www.kcca.go.ug/uDocs/ Energy%20and%20Climate%20Profile.pdf.
- 77 Ibid.
- 78 Ibid
- 79 Ministry of Energy and Mineral Development of the Republic of Uganda, *Draft National Energy Policy* (Kampala: 2019), https://www.energyandminerals.go.ug/site/assets/files/1081/draft_revised_energy_policy_-_11_10_2019-1_1.pdf.
- 80 KCCA, op. cit. note 76.
- 81 Ibid.
- 82 Ibid.
- 83 World Bank, Role of City Governments in Economic Development of Greater Kampala (Washington, DC: 2017), https://development-data-hub-s3-public.s3.amazonaws.com/ddhfiles/143567/119806-revised-public-the-wb-book-2017-report-web-individual-page-layout_0.pdf.
- 84 Ibid.
- 85 KCCA, Kampala Strategic Plan 2020/21 to 2024/25 (Kampala: 2020), https://www.kcca.go.ug/uDocs/Kampa-City-Strategic-Plan-2020-2025.pdf.
- 86 KCCA, op. cit. note 76.
- 87 T. Smith, "Uganda: Boda boda e-bike on a pay as you go model", Green Building Africa, 25 September 2020, https://www. greenbuildingafrica.co.za/uganda-boda-boda-e-bike-on-a-pay-as-you-go-model-to-boost-sector.
- 88 SEA, Data and Scenario Modelling Technical Report, Tsévié City, Togo, op. cit. note 17.
- 89 Ibid.
- 90 World Bank, Revue des Politiques du Secteur de l'Energie. Revue du Sous-Secteur de l'Electricité (Washington, DC: 2013), https:// openknowledge.worldbank.org/bitstream/handle/10986/16263/ ACS4990WP00FRE0ox0379826B000PUBLICO.pdf.
- 91 ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), Plan Actions National d'Efficacité Energétique (PANEE) (Praia: 2015), http://www.se4all.ecreee.org/sites/default/files/plan_actions_national_defficacite_energetique_panee_-_togo.pdf; ECREEE, Plan d'Actions National Des Energies Renouvelables (PANER) (Praia: 2009), https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Togo_Plan_d_Actions_National_des_Energies_Renouvelables.pdf.
- 92 ECREEE, Plan d'Actions National Des Energies Renouvelables (PANER), op. cit. note 91.
- 93 SEA, Data and Scenario Modelling Technical Report, Tsévié City, Togo, op. cit. note 17.
- 94 Ibid.
- 95 Ibid.
- 96 Ibid.
- 97 City of Tsévié, Plan en faveur d'un acces a une energie durable et du climat (PAAEDC). Convention des Maires d'afrique Sun Saharienne (Tsévié: 2020).
- 98 Ibio
- 99 H. Michel, City of Tsévié, personal communication with SEA, 2020.
- 100 Ibid

- 101 SEA, Rapport Technique Sur La Modélisation Des Scénarios Pour La Commune d'Arrondissement de Yaoundé IV, Cameroun, op. cit. note 17.
- 102 Wikipedia, "Yaoundé", https://en.wikipedia.org/wiki/ Yaound%C3%A9#Economy, viewed 28 October 2020.
- 103 GIZ, Analyse Nationale Cameroun (Brussels: CoM SSA, 2020).
- 104 IRENA, Cameroon Energy Profile (Abu Dhabi: 2020), https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Cameroon_Africa_RE_SP.pdf.
- 105 Ministry of the Economy, Planning and Regional Development of the Republic of Cameroon, Cameroun Vision 2035 (Yaoundé: 2009), http://extwprlegs1.fao.org/docs/pdf/cmr145894.pdf; Republic of Cameroon, CPDN Du Cameroun (Yaoundé: 2017), https:// www4.unfccc.int/sites/ndcstaging/PublishedDocuments/ Cameroon%20First/CPDN%20CMR%20Final.pdf.
- 106 GIZ, op. cit. note 103.
- 107 SEA, Rapport Technique Sur La Modélisation Des Scénarios Pour La Commune d'Arrondissement de Yaoundé IV, Cameroun, op. cit. note 17.
- 108 Ibid
- 109 Ibid.
- 110 Commune de Yaoundé IV, Plan d'Action Communal en faveur d'un Accès à une Energie Durable et du Climat (PACAEDC) (Yaoundé: 2020).
- 111 Ibid
- 112 SEA, Rapport Technique Sur La Modélisation Des Scénarios Pour La Commune d'Arrondissement de Yaoundé IV, Cameroun, op. cit. note 17
- 113 J-J. Belinga, City of Yaoundé IV, personal communication with SEA, 2020.
- 114 Ibid
- 115 IRENA, Scaling Up Renewable Energy Deployment in Africa, op. cit. note 10; RES4Africa Foundation, Scaling Up Africa's Renewable's Power: The Need for De-risking Investments and the Case for RenewAfrica (Rome: 2020), https://www.res4africa.org/wp-content/uploads/2020/07/RES4Africa-Foundation-Scaling-up-Africas-renewable-power.pdf.
- 116 IRENA, Scaling Up Renewable Energy Deployment in Africa, op. cit. note 10; RES4Africa Foundation, op. cit. note 115.
- African Development Bank, Sustainable Energy for All (SEforALL) Africa Hub and Sustainable Energy Fund for Africa, Green Mini-Grids in Sub-Saharan Africa: Analysis of Barriers to Growth and the Potential Role of the African Development Bank in Supporting the Sector (Abidjan: 2016), https://energy4impact.org/file/1818/download?token=j67HKZEy; RES4Africa Foundation, op. cit. note 115.
- 118 SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 119 S. Bawakyillenuo et al., "Chapter 4.3. Sustainable energy transitions in Sub-Saharan African cities: The role of local government", in P. Droege, Urban Energy Transitions: Renewable Strategies for Cities and Regions (Amsterdam: Elsevier Ltd, 2018), https://www.elsevier. com/books/urban-energy-transition/droege/978-0-08-102074-6.
- 120 T. Paulais, Financing Africa's Cities: The Imperatives of Local Investment (Washington, DC: 2012), https://www.afd.fr/en/ressources/financing-africas-cities-imperative-local-investment; African Centre for Cities, University of Cape Town and Pinsent Masons LLP, African Thought Leadership Programme, Roundtable 5: Urban Governance and Decentralisation (Pinsent Masons LLP, 2019), https://www.pinsentmasons.com/thinking/special-reports/african-cities-thought-leadership-programme.
- 121 African Centre for Cities, University of Cape Town and Pinsent Masons LLP, op. cit. note 120.
- 122 Ibid.
- 123 Mini-Grids Partnership, SEforALL and BloombergNEF, State of the Global Mini-Grids Market Report 2020: Trends of the Renewable Energy Hybrid Mini-grids in Sub-Saharan Africa, Asia and Island Nations (London: Bloomberg Finance L.P., 2020), https://minigrids.org/ wp-content/uploads/2020/06/Mini-grids_Market_Report-20.pdf.
- 124 IEA, op. cit. note 5, p. 145; Mini-Grids Partnership, SEforALL and BloombergNEF, op. cit. note 123; RES4Africa Foundation, op. cit. note 115.
- 125 M.P. Blimpo and M. Cosgrove-Davies, Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact (Washington, DC: World Bank, 2019), https://openknowledge.worldbank.org/bitstream/ handle/10986/31333/9781464813610.pdf.

- 126 SEA, op. cit. note 45.
- 127 Mini-Grids Partnership, SEforALL and BloombergNEF, op. cit. note 123.
- 128 S. Sambou, Dakar C40 City Advisor, personal communication with J. Nana, SEA, September 2020.
- 129 S. Bawakyillenuo et al., op. cit. note 119.
- 130 Ibid.; C40 Cities Climate Leadership Programme, Strategies to Increase the Deployment of Distributed Renewables in Sub-Saharan African Cities (London: November 2020), http://cityenergy.org.za/ uploads/resource_510.pdf; SEA, State of Energy in South African Cities Report 2020, op. cit. note 17.
- 131 Bawakyillenuo et al., op. cit. note 119; SEA, op. cit. note 45; M. Borchers et al., "Sustainable energy transitions: Changing the 'business as usual' trajectory in Sub-Saharan African urban areas", International Journal of African Development, vol. 5, no. 1 (2018), pp. 13-30, https://scholarworks.wmich.edu/cgi/viewcontent.cgi?article=1094&context=ijad.
- 132 Bawakyillenuo et al., op. cit. note 119; SEA, State of Energy in South African Cities Report 2020, op. cit. note 17; Tait and Euston-Brown, op. cit. note 11.



RENEWABLES IN CITIES 2021 GLOBAL STATUS REPORT



REN21 Secretariat

c/o UN Environment Programme 1 rue Miollis Building VII 75015 Paris France

www.ren21.net

ISBN 978-3-948393-01-4



