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Setting Incentives for Emission Reductions in Developing Countries: The Case of Social Housing in Colombia

Final report

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Setting Incentives for Emission Reductions in Developing Countries: The Case of Social Housing in Colombia

Final report

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Abstract: Setting Incentives for Emission Reduction in Developing Countries: The Case of Social Housing in Colombia

Colombia faces a number of challenges including growing electricity demand, increasing hydroelectric uncertainty as a result of changes in the el Niño weather phenomenon, and a growing need for social housing in metropolitan areas driven by accelerating urbanisation. At the same time, Colombia actively implementing its Nationally Determined Contribution (NDC) under the Paris Agreement. These include measures to improve energy efficiency in the residential sector overall. Some of which will also have a positive effect on energy efficiency in social housing. Policies for renewable electricity, building codes, and appliance energy performance standards all play a role in these efforts. However, these policies are not currently putting Colombia on a path towards the decarbonisation of the building sector that is needed to reach the temperature goals of the Paris Agreement. Through Article 6 of the Paris Agreement, countries can cooperate in NDC implementation to allow for higher climate ambition. This can offer opportunities for interventions in the building sector. Given the dynamic nature of the sector and number of actors, ensuring environmental integrity through an overall sectoral approach to Article 6 transfers is likely to be challenging especially in terms of additionality, baseline setting, and monitoring reporting and verification. However, there may be an opportunity to construct Net Zero Energy Buildings though an Article 6 pilot in the social housing sector, which would reduce energy consumption, reduce emissions, reduce energy poverty, reduce energy consumption subsidy payments, and improve public health and energy security. Such a pilot could, together with a larger policy roadmap towards increasingly stringent energy efficiency standards, help put the Colombian building sector on a path towards decarbonisation and alignment with the Paris Agreement.

Kurzbeschreibung: Schaffung von Anreizen für die Minderung von Emissionen in Entwicklungsländer: Das Fallbeispiel des sozialen Wohnungsbaus in Kolumbien

Kolumbien steht vor einer Reihe von Herausforderungen, darunter der wachsende Strombedarf, die zunehmende Unzuverlässigkeit der Stromerzeugung aus Wasserkraft infolge von Veränderungen durch das El Niño-Wetterphänomen, und ein rasch wachsender Bedarf an Sozialwohnungen in Metropolregionen, der durch die beschleunigte Urbanisierung verursacht wird. Gleichzeitig bemüht sich Kolumbien um die Umsetzung seines national festgelegten Beitrags (NDC) im Rahmen des Pariser Abkommens, welcher auch Maßnahmen zur Steigerung der Energieeffizienz im Gebäudebereich insgesamt umfasst. Einige davon werden sich auch positiv auf die Energieeffizienz im sozialen Wohnungsbau auswirken. Bei diesen Bemühungen spielen vor allem Richtlinien für erneuerbare Energien, Bauvorschriften und Energieeffizienzstandards für Geräte eine Rolle. Dennoch führt diese Politik Kolumbien derzeit noch nicht auf einen Pfad, der zur Dekarbonisierung des Gebäudesektors erforderlich ist, um die Temperaturziele des Pariser Abkommens zu erreichen. Länder können aber durch Artikel 6 des Pariser Abkommens bei der Umsetzung ihrer NDCs zusammenarbeiten, um ein höheres Ambitionsniveau im Klimaschutz zu erreichen. Aufgrund der Dynamik des Sektors und der Anzahl von Akteuren dürfte die Gewährleistung der Umweltintegrität bei einen sektoralen Ansatz für Transfers basierend auf Artikel 6 eine Herausforderung darstellen, insbesondere hinsichtlich Zusätzlichkeit, Baseline-Bestimmung und Überwachungs-, Berichterstattungs- und Prüfssystemen. Dennoch könnte ein Pilotprojekt zum Bau von Netto-Nullenergiegebäuden im sozialen Wohnungsbausektor eine Gelegenheit zur Zusammenarbeit durch Artikel 6 bieten. Netto-Nullenergiegebäude würden den Energieverbrauch reduzieren, Emissionen mindern, die Energiearmut reduzieren, die öffentlichen Haushalte durch den Abbau von Subventionen für den Energieverbrauch entlasten, und die öffentliche Gesundheit sowie die Energiesicherheit verbessern. Ein solches Pilotprojekt könnte zusammen mit einem umfassenderen politischen Fahrplan für immer strengere Energieeffizienznormen dazu beitragen, den kolumbianischen Gebäudesektor auf einen Weg der Dekarbonisierung im Einklang mit den Zielen des Pariser Abkommens zu bringen.

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List of abbreviations

AAU	Assigned Amount Unit
BAU	Business as Usual (Scenario)
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CAEM	Business Environmental Corporation of Bogota's Chamber of Commerce (*Corporación Ambiental Empresarial*, CAEM)
CDM	Clean Development Mechanism
CER	Certified Emission Reduction (CDM Unit)
COP	Conference of the Parties to the United Nations Framework Convention on Climate Change
CICC	Intersectoral Climate Change Commission (*Comisión Intersectorial de Cambio Climático*)
DANE	Colombia National Statistics Department (*Departamento Administrativo Nacional de Estadística*)
DEHSt	German Emissions Trading Authority
DNA	Designated National Authority
ECDBC	Colombian Low-Carbon Development Strategy (*Estrategia Colombiana de Desarrollo Bajo en Carbono*)
EDGE	Excellence in Design for Greater Efficiencies
ESCO	Energy Service Company
Fenoge	Fund for Non-Conventional Energy and Efficient Energy Management (*Fondo de Ener-gías No Convencionales y Gestión Eficiente de la Energía*)
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Green Investment Scheme
IET	International Emissions Trading
(I)NDC	(Intended) Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LEED	Leadership in Energy and Environmental Design
MEPS	Minimum Energy Performance Standard
NAMA	Nationally Appropriate Mitigation Action
NZEB	Net Zero Energy Building
OECD	Organization for Economic Cooperation and Development
PAS	Sectoral Mitigation Plans (*Planes de Acción Sectorial*)
PMR	Partnership for Market Readiness

PNACC	Climate Change National Adaptation Plan (*Plan Nacional de Adaptación al Cambio Climático*)
PoA	Clean Development Mechanism Programme of Activity
POT	Territorial ordering plan (*Plan de Ordenamiento Territorial)*
PROURE	Programme for the Rational and Efficient Use of Energy and Non-Conventional Sources (*Programa de Uso Racional y Eficiente de Energía y Fuentes No-Convencionales*)
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SISCLIMA	National Climate Change System (*Sistema Nacional de Cambio Climático)*
UBA	German Environment Agency (Umweltbundesamt)
UNFCCC	United Nations Framework Convention on Climate Change

Zusammenfassung

Weltweit sind Gebäude aktuell für etwa 9,18 Gigatonnen der Treibhausgasemissionen verantwortlich, was rund 19% der globalen Emissionen in 2010[1] entspricht (Lucon et al., 2014). Besonders in Entwicklungs- und Schwellenländer wird die schnell wachsende urbane Bevölkerung einen Ausbau der Gebäude und anderer Infrastruktur benötigen. Gleichzeitig ist eine radikale Verbesserung des Gebäudesektors eine wichtige Bedingung, um die Klimaziele des Pariser Abkommens zu erreichen und die Emissionen unter 2°C, oder gar 1,5°C zu halten. Dies erfordert in der zweiten Hälfte dieses Jahrhunderts eine Balance zwischen Emissionsquellen und -senken, wobei viele der erforderlichen Maßnahmen kostengünstig oder zu negativen Kosten umgesetzt werden können (Lucon et al., 2014). Für den Gebäudesektor bedeutet dies, dass die Emissionen des Sektors bis 2050 um 77% gesenkt werden müssen, um das 2°C Ziel noch zu erreichen. Um die globale Erwärmung unter 1.5°C zu halten, müssen die Emissionen des Sektors sogar um bis zu 90% gesenkt werden (Climate Action Tracker, 2016a).

Kolumbien ist keine Ausnahme von diesen globalen Trends und wird sich der Herausforderung einer rasanten Urbanisierung und daraus resultierendem Wohnungsmangel, besonders im sozialen Wohnungsbau, stellen müssen, während es den Verpflichtungen des Pariser Klimaabkommens nachkommen muss. Dies beinhaltet das Bestreben zur Dekarbonisierung des Gebäudesektors. Internationale Zusammenarbeit, sowohl durch internationale Klimafinanzierung, als auch durch Artikel 6 des Pariser Abkommens, könnte eine Möglichkeit sein, um privates Kapital zu mobilisieren und den kolumbianischen Gebäudesektor stärker auf einen klimakompatiblen und nachhaltigen Wachstumspfad zu bringen. Unabhängig davon werden solche Bemühungen jedoch ein signifikantes Mitwirken der Kolumbianer selbst benötigen, um die resultierenden Chancen bestmöglich zu nutzen und den Gebäudesektor Paris-kompatibel zu machen.

Kolumbien hat viel Erfahrung mit der Planung und Umsetzung von ambitionierter Klimapolitik. Das Land hat seine regionale Führungsrolle bereits bezüglich einer Anzahl verschiedener Klimaschutzmaßnahmen unter Beweis gestellt. Dazu zählen die Entwicklung und Implementierung von nationalen und internationalen Instrumenten zur CO_2-Bepreisung, einschließlich marktbasierter Instrumente. Kolumbien hat seinen angestrebten national festgelegten Beitrag („Intended Nationally Determined Contribution", INDC) im September 2015 eingereicht. Der Beitrag beinhaltet ein Minderungsziel von 20% für das Zieljahr 2030 gegenüber einem „business-as-usual" (BAU) Szenario. Unter der Bedingung internationaler Unterstützung beträgt das Minderungsziel 30%. Um seine Emissionsziele zu erreichen behält Kolumbien sich die Möglichkeit vor, marktbasierte Mechanismen zu nutzen, solange sie im Einklang mit Transparenzprinzipien und Umweltintegrität sind. Als Teil der UNFCCC Verhandlungsgruppe "Independent Association of Latin America and the Caribbean (AILAC)", ist Kolumbien stark in den internationalen Klimaverhandlungen engagiert, inklusive der Gestaltung von Marktmechanismen unter Artikel 6 und ist generell offen für internationale Zusammenarbeit durch marktbasierte Klimaschutzansätze.

Der Gebäudesektor stellt eine Gelegenheit dar, wo Kolumbien durch internationale Markt-Mechanismen eine solche Zusammenarbeit anstreben könnte. Im Jahr 2014 war Kolumbiens Gebäudesektor für rund 26% des gesamten Energieverbrauchs verantwortlich, wovon ein Großteil auf die Strom- und Gasnutzung zum Kochen und zur Erzeugung von Warmwasser entfällt. Bewohner von Sozialwohnungen („VIS/VIP") verbrauchen relativ wenig Energie, bekommen erhebliche staatliche Subventionen und sind von Energiearmut gefährdet. Obwohl der Stromsektor, dank der kolumbianischen Wasserkraftwerke, derzeit vergleichbar emissionsarm ist, führen Veränderungen des el Niño / la Niña Phänomens dazu, dass die Wasserressourcen in Zukunft

[1] Ausgenommen Landnutzung, Landnutzungsänderungen und Forstwirtschaft (LULUCF)

nicht mehr so zuverlässig sind. Zusätzlich zu seinen erheblichen Kohlereserven, verfügt Kolumbien über viel Potential für Erneuerbare Energien, besonders in der Guajira Region. Zukünftige Investitionen in die Energieerzeugung werden den Emissionsfaktor des Netzes bestimmen und haben damit einen großen Effekt auf die indirekten Emissionen des Gebäudesektors.

Laut der kolumbianischen Regierung flossen zwischen 2011 und 2015 über 6 Milliarden USD öffentlicher Gelder aus nationalen und internationalen Quellen in insgesamt 15.000 Klimaschutzprojekte. Für Minderungsmaßnahmen, mit zukünftig positiven Erlösströmen (z.B. Energieeffizienzmaßnahmen), können „Grüne Anleihen“ (mit öffentlichen als auch privaten Anleiheemittenten) ein wichtiges Instrument sein, um private Gelder für Klimaschutzmaßnahmen zu mobilisieren. Die Finanzmanagement-Arbeitsgruppe der nationalen Koordinierungsstelle für Klimaangelegenheiten (SICLIMA) unter der nationalen Planungsabteilung (DNP) arbeitet bereits an einer weiteren Entwicklung des Marktes für „Grüne Anleihen“. Wichtig zu erwähnen ist, dass der private Sektor aktiv Vorteile aus dem wachsenden Markt für „Grüne Anleihen“ zieht, um damit Minderungsaktivitäten zu finanzieren. Lokale Banken wie Bancolombia und Davivienda bieten Förderkredite für energieeffiziente Bauprojekte. Diese Projekte wurden teilweise durch Ausgabe von “Grünen Anleihen” finanziert, ein Trend dem Bancoldex, eine nationale Entwicklungsbank gefolgt ist. Öffentliche Entwicklungsbanken werden wahrscheinlich auch in Zukunft eine wichtige Rolle im Bereich der Energieeffizienz einnehmen.

Neben dieser inländischen und internationalen Klimafinanzierung erzeugt Kolumbien auch eine Inlandsnachfrage nach CO_2-Kompensationseinheiten. Kolumbien führte eine CO_2 Steuer auf flüssige Brennstoffe in Höhe von 15.000 COP/ tCO_2 (ungefähr 5 USD/ tCO_2) ein, welche seit dem 1. Januar 2017 gilt, und sich primär auf den Transportsektor bezieht. Einnahmen aus dieser Steuer können von der Regierung auch für Klimaschutzmaßnahmen in anderen Sektoren verwendet werden. Ein Merkmal der Kohlenstoffsteuer ist, dass Firmen ihre Steuerlast durch den Kauf von Kompensationsgutschriften mindern können. Diese Gutschriften stammen bisher hauptsächlich aus einheimischen Waldprojekten. Der Abschnitt des aktuellen Klimaschutzgesetzes, welcher eine Bestimmung über die Etablierung eines nationalen Emissionshandelssystems beinhaltet, wartet immer noch auf die Bestätigung durch die Regierung. Diese steht zum Zeitpunkt der Fertigstellung dieses Berichtes nach den Wahlen in 2018 weiterhin aus. Die CO_2-Bepreisung spielt derzeit keine große Rolle für die Finanzierung oder Bereitstellung von Anreizen zu Energieeffizienz im Gebäudesektor, könnte jedoch eventuell eine weitere Nachfragequelle für nationale Ausgleichsprojekte darstellen.

Obwohl Emissionen von Wohngebäuden und besonders von Sozialwohnungen nur einen kleinen Teil der gesamten kolumbianischen Emissionen ausmachen, stellt die Minderung dieser Emissionen aus zwei Gründen eine wichtige Klimaschutzmaßnahme dar. Erstens bedeutet die lange Lebenszeit von Gebäuden eine besondere Gefahr, dass langfristig ein emissionsintensiverer Emissionspfad eingeschlagen wird durch den sog. „Lock-in Effekt“. Zweitens können Emissionsreduktionen in Sozialwohnungen einen wichtigen “Spill-over” Effekt und andere Synergien mit weiteren wichtigen Regierungsprioritäten in Kolumbien haben. Beispielsweise reduzieren sich durch eine erhöhte Effizienz die erforderlichen staatlichen Energiesubventionen für ärmere Haushalte. Des Weiteren kann der Wechsel von Erdgas auf erneuerbare Energieträger die zukünftige Energiesicherheit stärken und zudem Luftverschmutzung reduzieren.

Zusätzlich zu staatlichen Energiesubventionen, steht der Gebäudesektor vor einer Vielzahl von Hürden um die Energieeffizienz zu verbessern. Diese sind beispielsweise ein fragmentierter Markt mit wechselnden Regeln und Vorschriften in verschiedenen Bereichen und eine große Anzahl an kleinen Baufirmen. Zudem fehlt es an Kapazitäten bei Architekten, Baufirmen, und Gutachtern, die in der Lage sind die Energieeffizienz von Gebäuden zu implementieren und prüfen. Speziell lokale Regierungen, die für die Durchsetzung der Gebäudenormen verantwortlich sind,

mangelt es an Wissen und speziell an Durchsetzungsfähigkeit. Daraus resultiert, dass es bisher nur wenige Fortschritte bei den Energieeffizienzmaßnahmen des Plan d'ordamiento Territorial (POTs) gibt, dem lokalen Planung- und Steuerungsinstrument. Größere Städte wie Bogota, Barranquilla und Cali sind generell weiter fortgeschritten bei der Berücksichtigung von Klimafragen in ihre POTs. Obwohl nur begrenzte Mittel für Energieeffizienzmaßnahmen zur Verfügung stehen, ist das tatsächliche Hindernis, dass diese Maßnahmen oft als teurer wahrgenommen werden, als sie eigentlich sind. Kostenobergrenzen für Sozialwohnungen, dämpfen jedoch die Bereitschaft sich für Maßnahmen zu engagieren, die in zusätzliche Kosten für die Baufirmen resultieren. Gegenläufige Anreize für Baufirmen, Hauskäufer und lokale Finanzierungsinstitutionen führen dazu, dass sogar Maßnahmen mit negativen Gesamtkosten nicht realisiert werden.

Der Wohnungssektor in Kolumbien ist in 6 Kategorien ("Strata") eingeteilt, welche in etwa das unterschiedliche Einkommensniveau reflektieren. Einwohner der Kategorie 1-3 werden zu den Geringverdienern gezählt und erhalten Förderungen, um ihnen einen „normalen Verbrauch" von Strom, Erdgas und Wasser zu ermöglichen. Einwohner der Kategorie 4 zahlen eine gemittelte Rate für die Energieversorgung und erhalten keine Förderungen. Einwohner in den Kategorien 5 und 6 zahlen eine höhere Rate für Strom, Erdgas und Wasser und kofinanzieren damit die Förderungen der Kategorien 1-3. Da der Großteil der kolumbianischen Bevölkerung der Kategorie 1-3 zugeordnet ist, gibt es ein Defizit, welches nicht durch den Beitrag der Besserverdiener gedeckt wird. Dies muss die Regierung aus Steuermitteln ausgleichen. Die Energiesubventionen verringern den Anreiz innerhalb der geförderten Kategorien in Energieeffizienzmaßnahmen zu investieren. Die Sozialwohnungsplanung und Finanzierung der Regierung ist unregelmäßig und abhängig von Wechseln zwischen verschiedenen Legislaturperioden, was genaue Vorhersagen zur zukünftigen Entwicklung von Sozialwohnungen erschwert. Nichtsdestotrotz ist sicher, dass die Nachfrage nach Sozialwohnungen in Zukunft im Rahmen der Urbanisierung steigen wird.

Die kolumbianische Regierung hat im Jahr 2015 die Verordnung 0549 verabschiedet, welche Energie- und Wassereffizienzmaßnahmen für verschiedene Gebäudetypen beinhaltet, diese jedoch nur auf freiwilliger Basis für Sozialwohnungen. Diese Maßnahmen variieren je nach Klimazone und Gebäudetyp. Dem Gesetz fehlt es jedoch an einer vollständigen Implementierung und Durchsetzung auf lokaler Ebene. In diesem Zusammenhang ist zu beachten, dass Energieeffizienzmaßnahmen aufgrund von Kapazitätsengpässen nicht von dem Mandat lokaler Gutachter abgedeckt sind. Es gibt allerdings eine Vielzahl an relevanten sub-nationalen Maßnahmen und Einrichtungen im Gebäudesektor, die sich für Energieeffizienz engagieren, z.B. „International Financial Corporation (IFC)" über das EDGE ("Excellence in Design for Greater Efficiencies") Programm, das "Building Energy Accelerator (BEA)" Programm in Bogata und eine Vielzahl anderer.

Viele der allgemeinen Herausforderungen für Energieeffizienzmaßnahmen stellen auch spezielle Hürden für die Generierung von Minderungsgutschriften in dem Sektor dar. Zusätzlich zu diesen Hürden erfordern die Regeln für den internationalen Transfer von Minderungsgutschriften ("international transfer of mitigation outcomes", ITMOs) unter Artikel 6, dass jede Maßnahme Umweltintegrität und Zusätzlichkeit sicherstellt, robuste Baselines definiert, zu Ambitionssteigerungen beiträgt, robuste Buchhaltung umsetzt, langfristige Klimavorteile und eine Förderung der nachhaltigen Entwicklung sicherstellt. Grundsätzlich erscheinen umfangreiche marktbasierte Maßnahmen basierend auf einem definierten Limit für einen (Unter-)Sektor bei gleichzeitiger Einhaltung der Anforderungen von Artikel 6 des Pariser Abkommens eher unwahrscheinlich. Jedoch könnten ambitionierte Pilotvorhaben für "Netto-Nullenergiegebäude (NZEB)" in einem limitierten Rahmen eine Rolle spielen, um Innovationen zu stärken und Vorreiter zu belohnen. Ein wichtiger Startpunkt könnte hier der soziale Wohnungsbau sein.

Pilotprojekte, die NZEB umsetzen, können daher eine wichtige Rolle zur Schaffung eines ambitionierten Präzedenzfalls für die Einführung von Effizienz und nachhaltiger Bauweise im Sektor

darstellen und Kolumbien helfen einen ambitionierten Dekarbonisierungspfad einzuschlagen. Zudem können sie in einem iterativen Prozess zur Orientierung von Gesetzesinitiativen in Richtung Dekarbonisierung beitragen. Ambitionierte Geldgeber könnten daher die Möglichkeit zur Förderung der Einführung von NZEB durch das Initiieren von marktbasierten Pilotprojekten unter dem Dach von transformativen Unterstützungsprogrammen als attraktive Option ansehen, um Erfahrungen im Zusammenspiel von post-Paris Klimafinanzierung und Kohlenstoffmarktfinanzierung zu sammeln, und um gleichzeitig dabei zu helfen eine sektorale Transformation in Kolumbien einzuleiten.

Für Entwicklungsländer wie Kolumbien stellt die Fokussierung auf die Dekarbonisierung neuer Gebäude aus folgenden Gründen eine Notwendigkeit dar, um die SDGs und ihre eigenen Ambitionen zu erreichen:

1. Kolumbien schätzt seinen Bedarf an neuen Wohnungen bis 2019 auf rund 3,9 Millionen, um das aktuelle Wohnungsdefizit zu stabilisieren und die Nachfrage durch die wachsende urbane Bevölkerung zu decken. Schon jetzt leben 76% der kolumbianischen Bevölkerung im städtischen Raum. Diese Zahl soll jedoch bis zur Hälfte des Jahrhunderts auf 85% anzusteigen.
2. 80% der kolumbianischen Bevölkerung fällt in die Kategorie der Geringverdiener (z.B. Kategorie 1 und 2), welche Strom und Brennstoffe zu stark subventionierten Preisen erhält. Ein gesenkter Energieverbrauch in diesem Bereich würde daher auch eine Reduzierung der Energiesubventionen bedeuten.
3. Selbst mit staatlichen Subventionen können die Energiekosten in manchen Gebieten für einen Großteil der Familien mit geringem Einkommen einen hohen Anteil ihres Familieneinkommen ausmachen und damit die Armut verfestigen.
4. Frühzeitige Maßnahmen bei Neubauten kontrollieren das Emissionswachstum im Gebäude- als auch dem Energiesektor.
5. Benachteiligte Einkommensgruppen leiden eher unter den negativen Gesundheitseffekten schlecht gebauter Wohnungen und suboptimaler Temperaturregelung – Reduktionsmaßnahmen im Gebäudesektor haben positiven Einfluss auf 10 von 13 Zielen für nachhaltige Entwicklung.

Sustainable Development Goals (SDGs)	**Typische Maßnahmen gegen den Klimawandel zu Energieeffizienz in Gebäuden und Industrie sowie Verbindungen zu SDGs**
	↑ Energiekosten für Haushalte reduzieren / Linderung von Energiearmut
	↑ Luftverschmutzung im Gebäude verringern und weniger innenraumbedingte Erkrankungen
	↑ Verbesserte Lernbedingungen.

	↑ Erfolgreiche Einführung von Programmen zur Emissions-reduzierung ist abhängig von Stärkung und Partizipation der Frau im Haushalt.	↑ Verbesserte Beteiligung für Randgruppen.
	↑ Verringerter Energieverbrauch und reduzierte Rechnungen.	
	↑ / ↓ Schaffung hochwertiger Jobs und neuer Industrien. (Hängt von politischen Optionen ab, um nachteilige Folgen von Arbeitsplatzverlusten in älteren Industrien zu vermeiden.)	
	↑ Verbesserte Effizienz und Wettbewerbsfähigkeit der Industrie.	
	↑ Die Belastung durch Energieausgaben ist für Geringverdiener größer.	
	↑ Investitionen verlängern die mögliche Nutzungsdauer von Gebäuden.	
	↑ Dekarbonisierte Städte; Anpassungsfähigkeit an extreme Wetterereignisse verbessern.	

Ein Pilot Artikel 6 Ansatz, der die Entwicklung von Netto-Nullenergie Sozialwohnungseinheiten in ausgewählten Gemeinden fördert, könnte eine Pionierrolle in Kolumbien einnehmen, welche dem Land bisher fehlt und nur unwahrscheinlich von allein entstehen wird. Ein Netto-Nullenergiegebäude ist ein Gebäude, welches keine Energie des Netzes über einen zuvor definierten Zeitraum (z.B. monatlich/ jährlich) benötigt. Dafür muss das Gebäude zum einen dahingehend optimiert werden, dass es die Energienachfrage für Heizen, Kühlen und Licht auf ein Minimum reduziert. Zusätzlich sollten energieeffiziente elektrische Geräte zum Einsatz kommen, die die Energienachfrage weiter senken. Die verbliebene Energienachfrage sollte dann durch selbst erzeugte erneuerbare Energie abgedeckt werden. Die Implementierung von Netto-Null Konzepten bei Neubauten stellt einen nützlichen Startpunkt für die Einführung von Netto-Nullenergiekonzepten dar.

Die Netto-Nullenergiegebäude (NZEB) Pilotmaßnahme ist eine vielversprechende Möglichkeit die internationale Kooperation unter Artikel 6 des Pariser Abkommens zu nutzen, um neue Netto-Nullenergiegebäude im sozialen Wohnungsbau in ausgewählten Städten Kolumbiens zu entwickeln. Beispiele solcher Netto-Nullenergiegebäude im sozialen Wohnungssektor sind aktuell nicht bekannt in Kolumbien. Die NZEB Pilotmaßnahme hat daher das Ziel das Konzept einzuführen und Technologie und Netto-Nullenergieansätze im kolumbianischen Markt zu etablieren. Beispiele an anderen Stellen zeigen, welche entscheidende Rolle solche Pilot- oder Demonstrationsprojekte zur Anregung eines Marktinteresses spielen, und so die weitere Aufnahme und Erzeugung nationaler Produktionsketten fördern. Der NZEB Pilot wird als freiwilliges Programm umgesetzt, um sektorale Entwicklungen zu beschleunigen und trägt zur Gestaltung zukünftiger Politikinstrumente bei, um NZEB auch in ganz Kolumbien zu etablieren.

NZEBs und ihre Rolle für die grundlegende Dekarbonisierung des Wohngebäudesektors wird derzeit weder im Markt, in Gesetzen oder in Entwicklungsunternehmen Kolumbiens betrachtet, noch hat das Land bisher eine langfristige Dekarbonisierungsstrategie veröffentlicht.

Technische Minderungsmaßnahmen zur Verbesserung der Performance von Netto-Nullenergiegebäuden im Sozialwohnungsbau sollten besonders auf zwei Dimensionen fokussieren. Erstens sollten neue Pilotprojekte in VIS und VIP Wohngebäuden in ihrem Design und Energieverbrauch hoch energieeffizient sein. Zweitens sollten sie erneuerbare Energien wie Photovoltaik und Solarthermie enthalten, um den verbleibenden Energiebedarf im Monats- oder Jahreszyklus decken zu können. Basierend auf dem Energieverbrauchsprofil des Sektors und Maßnahmen, die bereits in laufenden Initiativen diskutiert wurden, sollten Netto-Nullenergiegebäude folgende Maßnahmen berücksichtigen:

1. **Passive Maßnahmen** – Passive Maßnahmen haben mit der architektonischen Gestaltung des Gebäudes zu tun. Diese Charakteristika bestimmen Art, Form und Details der Gebäudehülle welche direkt mit dessen Energieeffizienz verbunden sind. Einige Beispiele von zwingenden Maßnahmen beinhalten:

    a) Natürliche Beleuchtung durch Fassaden und/oder Deckenlichtern;

    b) Natürliche Belüftung um den Energiebedarf des Gebäudes zu senken;

    c) Gebäudeausrichtung zur Reduzierung des Heiz- und Kühlbedarfs; und

    d) Gebäudeisolierung. Die Gebäudeisolierung wird durch U-Werte der Außenwände, Dächer und Fenster bestimmt. U-Werte liefern eine Bewertung des Isolierungslevels des Gebäudes. Die besten Isolierungsmaterialien haben einen U-Wert der nah an Null liegt; je niedriger desto besser.

2. **Aktive Energieeffizienzmaßnahmen –** Diese beziehen sich auf das installierte Equipment oder Geräte, die mit dem Haus verkauft werden zum Heizen- Kühlen, Kochen, Beleuchtung etc. und die sich mit der Verbesserung der Energieeffizienz dieser Geräte befassen, um den Energiebedarf des Gebäudes zu reduzieren. Aktive Maßnahmen beziehen sich beispielsweise auf:

    a) Beleuchtung – z.B. LEDs für Innenräume, LEDs für draußen und Bewegungsmeldern in Gängen oder Außenbereichen. Die Verbreitung von LED Beleuchtung innerhalb der unteren Einkommensschichten war verlangsamt (UPME, 2017), dies sollte sich aber durch den weiteren Preisverfall für neue LEDs inzwischen verändert haben.

    b) Geräte – Diese beziehen sich auf die Verwendung von energieeffizienten Geräten im Haus, wie beispielsweise Kühlschränke, Bügeleisen, Fernseher, Küchengeräte,

Computer, etc. Dies stellt jedoch eine Herausforderung dar, denn VIS/VIP Gebäude werden ohne Einrichtung verkauft. Würde man diese Sozialgebäude mit elektrischen Geräten verkaufen, würde dies die Kosten erhöhen, was aufgrund der Kostenobergrenze für diese Gebäude kaum möglich ist. Eine Möglichkeit dies zu umgehen ist die Geräte über ein ESCO Modell zu vermieten, bei dem ein Serviceanbieter die Geräte besitzt und diese vermietet.

3. **Wechsel von Erdgas zu Strom zum Kochen** – Derzeit macht Kochen etwa 50% des gesamten Energieverbrauchs in urbanen kolumbianischen Haushalten aus. Erdgas ist der Hauptenergieträger zum Kochen, gefolgt von einem kleinen Anteil an LPG und Strom. Ein Wechsel von Erdgas zu Strom zum Kochen ist notwendig, um ein Netto-Nullenergiebilanz zu erreichen. Um den Energieverbrauch zu optimieren, sollten zudem hocheffiziente Herde wie Induktionsherde gefördert werden, da diese mit bis zu 90% Effizienz arbeiten (Sadhu, Pal, Bandyopadhyay, & Sinha, 2010).
4. **Installation von emissionsarmen Energieerzeugungstechnologien –** Zwei der relevanten Technologien für Netto-Nullenergiegebäude in dieser Region sind:
    a) Solare Warmwasserbereiter (SWH) um die Nachfrage nach Wärmeenergie für Warmwasser zu decken
    b) Gebäudeeigene Photovoltaikanlage, um den verbleibenden Strombedarf des energieeffizienten Hauses zu decken.

Kostenschätzungen für NZEB im Vergleich zu normalen Gebäuden, die im Einklang mit den aktuellen Standards der Verordnung 549 sind, bleiben bisher unklar. Obwohl die resultierenden Kosten der Verordnung für Maßnahmen, die freiwillig von Baufirmen umgesetzt werden können, voraussichtlich geringer als 2% des Hauspreises sein werden, sind Verbesserungen zu aktuellen Clean Development Mechanism (CDM) Marktpreisen eher unwahrscheinlich.

Ein Unterstützerland zeigt unterdessen bereits Interesse an bilateralen Abkommen die NZEB als Wegbereiter und Demonstrationsprojekt der Dekarbonisierung des kolumbianischen Sozialwohnungssektor fördern, und strebt die weitere Finanzierung von Untersuchungen zur Kostenbewertung und Machbarkeit an. Ein solches Pilotprojekt könnte besonders für Partnerländer von Interesse sein, die viel Wert auf eine langfristige Transformation von Sektoren legen und Co-Benefits als Beitrag zur nachhaltigen Entwicklung wie Linderung der Armut, verbesserte Gesundheit, Zugang zu sauberer Energie, Schaffung von Arbeitsplätzen sowie nachhaltige Städte und Gemeinden bevorzugen.

Für den Netto-Nullenergie Pilotansatz, empfehlen wir einen Benchmark als Grundlage für zertifizierbare Reduktionen zu definieren, der sich an der geänderten Fassung der Verordnung 549 orientiert. Dieser Benchmark ist strenger als die gängige Praxis Energieeffizienz. Die Differenz zwischen der gängigen Praxis und dem Benchmark für anrechenbare Reduktionen stellt den Beitrag des Pilotprojekts zu Kolumbiens NDC dar. Der Benchmark kann darüber hinaus noch angepasst werden um zusätzlich den „Netto-Minderungsbeitrag“ zu erreichen.

Als Teil des Netto-Nullenergie Pilotprojektes würde ein „Ambitionstrigger“ so gestaltet werden, dass die Teilnehmer des Projektes zunächst einen Netto-Nullenergie Status erreichen müssen, bevor sie Gutschriften erhalten. Der Ambitionstrigger ist so definiert, dass er einen Weg zur Dekarbonisierung des Sektors im Einklang mit dem Pariser Abkommen sicherstellt. Auch wenn ein Gebäude eine marginale Verbesserung gegenüber dem Benchmark erreicht, würden gleichzeitig alle verbleibenden Emissionen so lange festgeschrieben werden, bis eine zukünftige Nachrüstmaßnahme sie beseitigt. Der zusätzliche „Ambitionstrigger“ bietet einen Ansporn, effizienter zu

bauen und wird durch den Umstand erzeugt, dass Gutschriften nur ausgegeben werden, wenn ein Projekt den NZEB Status erreicht.

Das vorgeschlagene Pilotprojekt könnte nicht nur bei Gebäuden im Geltungsbereich des Projektes helfen, sondern auch positive „Spillover"-Effekte durch Technologietransfer, verstärkte Technologiedurchdringung und praktische Erfahrungen beisteuern. Dennoch gilt es soziale, ökonomische und finanzielle Herausforderungen und Marktbarrieren zu überwinden, wofür ein einzelnes Gesetz zu NZEB für alle oder auch nur neue Gebäude wahrscheinlich nicht ausreicht. Stattdessen wird ein umfassendes Gesetzespaket benötigt, welches die Barrieren adressiert und die verschiedenen Akteure aktiviert. Ein Gesetzespaket sollte sich darauf konzentrieren direkte Emissionen der Gebäude zu verhindern, den Energieverbrauch und damit auch die indirekten Emissionen deutlich zu verringern; und gebäudeeigene erneuerbare Energieerzeugung zu fördern. Neubauten sind ein wichtiger Anfangspunkt für regulatorische Eingriffe um den „lock-in" von Emissionen in der zukünftigen Bausubstanz zu verhindern. Darüber hinaus müssen politische Vorgaben für Neubauten auch von einer ambitionierten Renovierung der bestehenden Bausubstanz begleitet werden.

Verbindliche Energieeffizienzstandards für Gebäude („Mandatory building energy performance standards", MBEPS) sind das Herz der Regulierung im Gebäudesektor: Die Notwendigkeit einer solchen Regulierung kann nicht einfach durch einen marktbasierten Eingriff ersetzt werden. Mindestenergieeffizienzstandards für Neubauten können in bestehende Bauvorschriften integriert werden oder als alleinstehende verbindliche Gebäudenorm entworfen werden. MBEPS definieren in der Regel Mindeststandards über die allgemeine Performance des Gebäudes (z.B. Energieverbrauch/m^2). Diese Energieeffizienzberechnung berücksichtigt meist Eigenschaften der Gebäudehülle wie das architektonische Design, natürliche Beleuchtung etc. sowie einige elektrischen Geräte (Heizung, Kühlung, Heißwasser, Beleuchtung etc.).

Gebäudeenergieeffizienzstandards entwickeln sich vermehrt weg von normativen hin zu leistungs- oder ergebnisorientierten Ansätzen. Normative Effizienzstandards beschreiben die Bauweise, in der Gebäude errichtet werden sollen um spezielle Energieeffizienzziele zu erreichen. Während normative Standards gegenüber anderen Methoden den Vorteil haben strukturiert, einfach und leicht kontrollierbar zu sein, so werden sie aber auch von Marktteilnehmern als Hindernis bezüglich Flexibilität, Innovation und Kostenoptimierung angesehen. Des Weiteren müssen normative Standards laufend aktualisiert werden, um die schnelle Marktentwicklung im Bereich der Energieeffizienz und erneuerbaren Energien zu reflektieren. Diese Marktentwicklung fortlaufend abzubilden, bedeutet einen erheblichen Verwaltungsaufwand für die Behörden.

Viele Länder mit Erfahrung bei der Gebäudeenergieeffizienz sind von rein normativen Vorgaben, die beschreiben „was zu tun ist, um das Ziel zu erreichen" übergegangen zu einem ergebnisorientierten Ansatz, bei dem der Gesetzgeber nur das Ziel bestimmt, sowie die Kennzahlen, die beschreiben wann dieses erreicht wird.

Allgemein können folgende Empfehlungen gegeben werden, um die zukünftigen Bedürfnisse des Sektors zu adressieren und den Energieverbrauch und die Emissionen zu senken, sowie gleichzeitig einen Weg zu entwerfen, der konsistent zu dem Pariser Abkommen ist und die teuren Subventionsausgaben der Regierung reduziert:

1. **Entwicklung eines langfristigen Ziels und einer Strategie um Netto-Nullenergiegebäude Teil einer langfristigen Dekarbonisierungsstrategie zu machen.**

    a) So ein Ziel könnte vom Nationalen Wirtschafts- und Sozialrat (CONPES) definiert werden, einschließlich einer Skala, die den Fortschritt in Richtung Netto-Nullenergie abbilden kann. Solch eine Planung sollte Gelder mit einbeziehen, die sonst in Förderungen des Energieverbrauchs geflossen wären.

b) Ein solches Ziel sollte sich zudem zunächst auf Neubauten fokussieren, um das Festschreiben von hohem Energieverbrauch und Emissionen zu verhindern und dann von Bemühungen flankiert werden die Energieeffizienz bestehender Gebäude durch Renovierung und andere Maßnahmen wie Gerätestandards verbessern.

2. Klein anfangen und verbreiten

a) Kolumbien könnte zusammen mit ambitionierten internationalen Partnern ein NZEB Pilotprojekt in Erwägung ziehen, um das Potential innovativer Geschäftsmodelle sowie der besten verfügbaren Technologien aufzuzeigen, Vorreiter belohnen und die bessere Durchdringung in der Praxis zu forcieren.

3. Herausforderung der Urbanisierung begegnen durch Fokussierung auf Regionen mit massiven urbanem Bevölkerungswachstums, einschließlich der Nachfrage nach Sozialwohnungen.

a) Die Metropolregion Bogota, Medellin und Cali werden wahrscheinlich den Großteil des Bevölkerungswachstums und der Bauaktivität tragen. Diese jeweiligen regionalen Regierungen sind vergleichsweise gut aufgestellt für die Einführung von Klimagesetzen, verfügen über den politischen Willen und setzten ohnehin schon Maßnahmen zur Emissionsreduktion im Gebäudebestand um, wie beispielsweise mit dem BEA Programm. Maßnahmen zur Energieeffizienz sollten sich auf diese Städte fokussieren.

b) In einem zweiten Schritt sollten ambitionierte mittelgroße Städte in den Fokus zum Kapazitätsaufbau treten, möglicherweise in einer Partnerschaft mit schon trainierten und erfahrenden Kollegen aus den größeren Metropolregionen.

4. Aktualisierung und Reform des Leitfadens für nachhaltiges Bauen

a) Während die Vorschriften für nachhaltiges Bauen für Sozialbauten derzeit freiwillig sind, sind die Kosten vieler Energieeffizienzmaßnahmen seit der Erstveröffentlichung des Leitfadens gesunken. Eine Reform und Optimierung von bestehenden Praktiken und Technologien kann schon zu erheblichen Energieeinsparungen führen; auch ohne weitere nationale oder internationale Unterstützung. Ein Kapazitätsaufbau und das Bereitstellen von Mitteln zur Einhaltung des Leitfadens kann den Akteuren helfen die reformierten Vorgaben einzuhalten.

b) Selbst für Gebäude, die in den nächsten Jahren gebaut werden und keine eigene erneuerbare Energieerzeugung haben (PV oder solare Warmwassererzeugung), sollten die Gebäudenormen bereits jetzt Dächer fordern, die die spätere Nachrüstung solcher Technologien erleichtern. Dies ist ein kostengünstiger Weg, um zukünftige Maßnahmen zur Dekarbonisierung des Sektors zu erleichtern.

c) Flexibilität erhöhen. Der Übergang von Technologievorschriften zu Effizienzstandards führt zu größeren Einsparungen. Diese Flexibilität reduziert den Verwaltungsaufwand und ermöglicht es Entwicklern innovativer zu sein und schneller auf neue Technologien und Ansätze zu reagieren.

d) Vereinfachungen: Baselines für Sektoren zu definieren kann schwierig sein und diese können schnell wieder veraltet sein. Das Messen von Energieeffizienz im Gebäudesektor sollte vom Ansatz bezogen auf „% und Maßnahme“ zu „absoluten minimalem Energieverbrauch (Energie/m^2)“ wechseln.

5. Entwicklung eines robusten Kontrollsystems

a) Das Einhalten von Energieeffizienzstandards sollte in die POTs der Gemeinden integriert werden. Diese sollten eine regelmäßige Datenabfrage einführen, um das Einhalten der Standards

zu überprüfen. Synergien können sich zudem durch die Planungen der Regierung zur Installation von intelligenten Zählern in ganz Kolumbien bis 2030 ergeben.

b) Definition von klaren Vorgaben zum Nachweis der Einhaltung der Verordnung 549 – Entwicklung eines eigenen Zertifizierungsansatzes oder Verwendung eines bereits bestehenden (EDGE, LEED, oder andere) und Training / Ausstattung von Gutachtern damit sie die Einhaltung der Vorgaben vor Ort verifizieren können.

6. Definition von Richtlinien über das Design des Gebäudes hinaus

a) Verpflichtende und regelmäßig aktualisierte Mindestenergieeffizienzstandards können den Umstieg besonders bei Geräten und Beleuchtung fördern. Dies kann durch weitere Gesetze begleitet werden in denen Kolumbien bereits Erfahrung hat, wie der Ausstieg aus ineffizienten Produkten wie Glühbirnen.

b) Kolumbien hat kürzlich Regelungen für „Net-Metering“ erlassen. Eine weitere Förderung von Solarthermie und PV in Häusern für Hausbesitzer bzw. Mieter kann zudem das Emissionsprofil des kolumbianischen Gebäudesektors verbessern.

c) Entwicklung gezielter Regelungen, um das Kochen und die Warmwasseraufbereitung zu elektrifizieren, um so die Erdgasnutzung und -nachfrage zu reduzieren.

7. Anreize schaffen, über Mindestanforderungen hinauszugehen

a) Instrumente der „Anerkennung“ können eine Motivation sein, über die Mindeststandards hinauszugehen. Solche Instrumente können Gebäudelabels - auch mit Angabe der Übererfüllung eines Standards (“stretch standards“) - oder Wettbewerbe und Auszeichnungen sein (z.B. für Netto-Nullenergie-Demonstrationsgebäude).

b) Anreize für ambitioniertere Entwickler. Zu diesen Anreizen könnten auch Vorzugszinsen lokaler Banken für sehr energieeffiziente Häuser gehören, die über die derzeitigen Programme von Bancolombia und Davivienda hinausgehen; oder auch reduzierte Mehrwertsteuersätze bzw. die Priorisierung bei der Erteilung von Baugenehmigungen. Diese Anreize sollten mit Gebäudelabeln oder Zertifikaten verbunden werden, die über die Regelungen der Verordnung 549 hinausgehen.

8. Die Rolle von ESCOs für den Wohnungsbausektor beleuchten

a) Eine solche Unterstützung könnte Regelungen beinhalten, wie beispielsweise Mehrwertsteuerbefreiungen, geförderte Darlehen oder Programme die ESCOs zur Zusammenarbeit mit Baufirmen anregen.

9. Verbesserung der Koordination und des Austauschs zwischen den beteiligten Akteuren

a) Abstimmung zwischen Rollen und Verantwortlichkeiten der Ministerien beispielsweise durch spezielle Arbeitsgruppen, welche eine Vielzahl verschiedener relevanter Regierungsstellen beinhalten wie zum Beispiel das Umweltministerium, das Energie- und Gebäudeministerium und die lokalen Regierungen.

10. Neue Kapazitäten aufbauen

a) Formalisiere regulatorische Rollen – wer plant, wer koordiniert, wer implementiert, wer überwacht, wer verifiziert, wer überprüft, wer setzt durch.

b) Konzentrierte Anstrengungen zum Aufbau von Kapazitäten der Kommunen zur Integration von Energieeffizienz und Standards zur Erzeugung erneuerbarer Energien in die lokalen Planungsvorschriften (dem Plan de ordenamiento territoral or POT), und von verbesserten Vollzugskapazitäten.

c) Ausbildung und Vergrößerung der Anzahl von zertifizierten Gebäudegutachtern.

Der Bausektor und insbesondere der soziale Wohnungssektor, obwohl kein großer Emittent, ist dennoch ein wichtiger Sektor für weitere Maßnahmen, sowohl im Hinblick auf die Bedürfnisse der wachsenden städtischen Bevölkerung in Kolumbien als auch im Hinblick auf die Erfüllung der Verpflichtungen aus dem Pariser Abkommen bezüglich der nachhaltigen Entwicklung. Durch Artikel 6 des Pariser Abkommens können Länder bei der Umsetzung ihrer NDCs zusammenarbeiten, um ein höheres Ambitionsniveau im Klimaschutz zu erreichen. Aufgrund der Dynamik des Sektors und der Anzahl von Akteuren dürfte die Gewährleistung der Umweltintegrität bei einem sektoralen Ansatz für Transfers basierend auf Artikel 6 eine Herausforderung darstellen, insbesondere hinsichtlich Zusätzlichkeit, Baseline-Bestimmung und Überwachungs-, Berichterstattungs- und Prüfsystemen. Dennoch könnte ein Pilotprojekt zum Bau von Netto-Nullenergiegebäuden im sozialen Wohnungsbausektor den Energieverbrauch reduzieren, Emissionen mindern, die Energiearmut reduzieren, die öffentlichen Haushalte durch den Abbau von Subventionen für den Energieverbrauch entlasten, und die öffentliche Gesundheit sowie die Energiesicherheit verbessern. Ein solches Pilotprojekt für ein Netto-Nullenergiegebäude könnte zusammen mit einem umfassenderen politischen Fahrplan für immer strengere Energieeffizienznormen dazu beitragen, den kolumbianischen Gebäudesektor auf einen Weg der Dekarbonisierung im Einklang mit den Zielen des Pariser Abkommens zu bringen.

Summary

Globally, buildings were responsible for 9.18 giga tonnes of greenhouse gas emissions or 19% of global emissions in 2010 (Lucon et al., 2014). Especially in developing and emerging economies, rapidly growing and urbanising populations will require more housing and infrastructure expansion. At the same time, radical improvement of the building sector is an urgent challenge to address in order to meet the objectives of the Paris Agreement to limit global warming to well below 2°C with best efforts for 1.5C. This requires reaching a balance between emission sources and sinks in the second half of this century, much of which can be done cost effectively or even at negative costs (Lucon et al., 2014). For the building sector, this means that to limit global warming to 2°C, global emissions from the building sector need to fall by 77% by 2050 compared to 2010; to limit global warming to 1.5°C, emissions need to fall by up to 90% (Climate Action Tracker, 2016a).

Colombia is no exception to these global trends and will face the challenges of rapid urban growth and the associated housing shortages, especially for social housing, while meeting its commitments under the Paris Agreement. This includes working towards decarbonisation of the building sector. International cooperation, both through international climate finance and possibly also through the opportunities presented through Article 6 of the Paris Agreement, may present options to help mobilise private capital and steer the Colombian building sector towards a more climate compatible and sustainable growth. Such efforts however will regardless require significant Colombian domestic effort to make the most of opportunities and steer the building sector to a Paris compatible pathway.

Colombia has a long track record in ambitious climate change planning and policy making. It has demonstrated regional leadership regarding a number of climate measures, including the development and implementation of domestic and international carbon pricing instruments, including market-based instruments. Colombia submitted its Intended Nationally Determined Contribution (INDC) in September 2015. The INDC provides for an unconditional, single year target of 20% emission reduction across all sectors by 2030 compared to a business as usual (BAU) scenario. Colombia has said they may increase the target to 30% with international support. The INDC notes the option to use market-based mechanisms – in line with principles of transparency and environmental integrity – to achieve its emission reduction target. As part of the Independent Association of Latin America and the Caribbean (AILAC) negotiating bloc in the UNFCCC, Colombia is heavily engaged in international climate negotiations surrounding the design of market mechanisms under the Paris Agreement (Article 6) and is generally open to international cooperation through market approaches for climate change mitigation.

One possible sector in which Colombia could seek cooperation through international market mechanisms could be the building sector. The Colombian building sector represented almost 26% of total energy consumption in 2014, mostly electricity and some gas consumption used primarily for cooking and hot water heating. Residents of social housing (VIS/VIP) consume relatively small amounts of energy, receive significant subsidies from the state, and are vulnerable to energy poverty. Although the electricity sector is currently comparatively clean, thanks to Colombia's hydroelectric resources, changes in the el Niño / la Niña phenomenon means that hydro resources will become less certain in the future. Although it has significant domestic coal resources, Colombia also enjoys an abundance of renewable energy potential, in particular in the la Guajira region. Future electricity sector investments will determine the grid emission factor and therefore have a large effect on the indirect emissions from the building sector.

According the Colombian government, over $6 billion USD of public funds, both domestic and international, flowed to 15,000 different climate change measures in Colombia between 2011

and 2015. For mitigation measures with a positive future revenue stream (e.g. energy efficiency measures), green bonds (with both public and private debt issuers) can be a particularly important tool to mobilise private finance for climate mitigation. The financial management working group of the Colombian national climate action coordination body (SISCLIMA) under the National Planning Department (DNP) has been working on further green debt market development. Importantly, the private sector is actively taking advantage of a growing green bond market to finance mitigation activities. Local banks such as Bancolombia and Davivienda offer promotional interest rates for energy efficient construction projects. These efforts have in part been financed through Green Bond issuances, a trend that has been followed by Bancoldex, a national development bank. Public development banks will likely have an important role to play in the field of energy efficiency in the future.

In addition to such domestic and international climate finance, Colombia also generates domestic demand for carbon offsets. Colombia imposed a carbon tax of of COP 15,000/tCO_2 (approximately 5 USD/tCO2) on liquid fuels starting on 1 January 2017, which primarily applies to the transportation sector. Revenues from the tax can be used for government efforts to encourage further climate change action in other sectors. An offsetting provision in the carbon tax allows companies to comply with the tax through the use of offsets. This has so far primarily been used for domestic forestry projects. The recent passage of a climate law that includes a provision for the establishment of a national emissions trading scheme still requires presidential approval. This is unclear at the time of report writing after the 2018 elections. Carbon pricing does not currently play a large role in financing or providing an incentive for energy efficiency in the building sector but could conceivably provide a further source of demand for domestic offsets.

Although emissions from residential housing - and particularly social housing - constitute a relatively small share of Colombian overall national emissions, reducing those emissions is an important mitigation opportunity for two reasons. First, the long lifetime of housing assets means that there is a particular danger of a lock-in to (higher) emission pathways. Second emission reduction measures in the social housing sector can have important potential spill-over effects and synergies with other relevant government priorities in Colombia. For instance, increased efficiency would reduce the financial burden of energy subsidies to poorer households. Further, switching from natural gas to renewable energy, future energy security can be increased and air pollution reduced.

In addition to energy consumption subsidies, the building sector in general faces a number of challenges to improve energy efficiency. These include a fragmented market, with varying rules and regulations in different areas and a large number of small construction firms. There is also a lack of capacity in terms of architects, building construction firms, and verifiers that are able to implement and check on energy efficiency performance. Specifically, local governments, who are responsible for checking compliance with building codes lack capacity, especially enforcement capabilities. As a result, they have generally not moved forward with energy efficiency measures in the Plan d'ordamiento Territorial (POTs), the local planning regulatory tool. Larger cities such as Bogota, Barranquilla, and Cali are generally more advanced in integrating climate considerations into their POTs. Although there is limited capital available for energy efficiency measures, the real barrier to these measures is that they are often perceived to be more expensive than they actually are. Price caps for social housing, however, dampen willingness to investigate any measures that cost more for construction companies. Split incentives between construction companies, homebuyers, and local financial institutions means that even measures associated with negative overall costs often go unrealised.

The residential sector in Colombia is divided into 6 strata, roughly based on income. Residents in strata 1-3 are considered lower income and receive subsidies for a level of "normal

consumption" of electricity, gas, and water. Residents in strata 4 pay an average rate and receive no subsidies. Residents in strata 5 and 6 pay higher rates for electricity, gas, and water to cross subsidise lower income residents. The majority of the Colombian population is in strata 1-3 and the national government must make up for the deficit of subsidies that is not covered by the higher rates of strata 5-6. Such subsidies undermine an incentive for residents in these strata to invest in energy efficiency measures. Government planning and financing of social housing varies over time and from legislative period to legislative period, making accurate projections for future social housing challenging. However, the need for social housing will increase with urbanisation.

In 2015, the Colombian government passed Resolution 0549, which included energy efficiency and water efficiency measures that are mandatory for various classifications of buildings, but voluntary for social housing. These vary by climate zone and type of building. The policy lacks full scale implementation and enforcement on the local level. Importantly, energy efficiency measures are excluded from the mandate of local building inspector because of capacity limitations. There are, however, a number of relevant sub-national measures and international cooperation measures actively working on energy efficiency in the sector including the International Financial Corporation (IFC) through the EDGE (Excellence in Design for Greater Efficiencies) programme, the Building Energy Accelerator (BEA) programme in Bogota, and a number of others.

Many of the challenges for energy efficiency measures in general also apply for efforts to credit emission reductions on a sectoral level. In addition to these challenges, the provision for the international transfer of mitigation outcomes (ITMOs) under Article 6 means that any carbon market intervention will need to ensure environmental integrity and additionality, set robust baselines, contribute to ambition, enforce robust accounting, offer long term climate benefits, and foster sustainable development. Overall, large scale sectoral market intervention based on a fixed (sub) sectoral limit in keeping with the principles found in Article 6 of the Paris Agreement is not likely to be feasible. However, there may be a role for an ambitious pilot intervention for Net-Zero Energy Buildings (NZEB) on a limited scale to foster innovation and reward first movers. An important place to start may be the social housing sector.

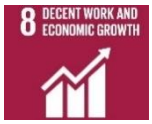
Pilot projects demonstrating NZEB could therefore fulfil an important niche in setting an ambitious precedent to introduce efficient, sustainable building practices in the sector and help Colombia leapfrog to a deep decarbonisation pathway in the sector. Moreover, it can provide an iterative process to inform policy orientation towards decarbonisation. Ambitious donors may therefore find the approach of facilitating introduction of NZEBs by nesting market-based pilots under a transformative policy support programme to be an attractive option to gain experiences with post-Paris climate finance and carbon finance cooperation, while supporting sectoral transformation in Colombia.

For developing countries like Colombia focussing efforts on decarbonising new buildings is a necessity to achieve the SDGs and in its own interest because:

1. Colombia estimates it needs to build 3.9 million new homes by 2019 to stabilise its current housing deficit and meet housing demand of the growing urban population. Already 76% of Colombian population is urban dwelling. This number is set to rise to 85% by mid of this century.

2. 80% of Colombian population falls in the lowest housing strata (i.e. strata 1 and 2) which gets power and fuels at heavily subsidised rates. Lower energy use in lower strata particularly will lower the costs of government subsidies.

3. Even with government subsidies, in certain areas the cost of energy can make up a significant burden accounting for a significant portion of lower income family salaries, perpetuating poverty;
4. Early action on new buildings checks for emission growth in both buildings and energy sector.
5. Disadvantaged income groups are more likely to suffer from negative health effects of poorly built housing and suboptimal temperature regulation - building sector mitigation positively impacts on 10 of the 13 sustainable development goals.

Sustainable Development Goals (SDGs)	**Typical measures for climate change action on Energy efficiency in buildings and industry and linkages to SDGs**
	↑ Reduce household energy bills / alleviation of energy poverty.
	↑ Reduce indoor air pollution and sick building syndrome.
	↑ Enhance conditions for learning.
	↑ Successful introduction of programmes for reducing emissions depends on empowerment and participation of women in the household. ↑ Increased accessibility for marginalised groups and people.
	↑ Reduce energy consumption and bills.
	↑ / ↓ Creation of decent jobs and new industries. (Depends on policy options to avoid adverse outcomes of job losses in older industries.)
	↑ Improve efficiency and competitiveness of industry.
	↑ Energy expenditure burden is greater for lower income groups.

	↑ Investments extend useable lifetime of built environment.
	↑ Decarbonise cities; improve resilience to extreme weather.

A pilot Article 6 programme that promotes development of net-zero energy social housing units in selected municipalities could serve a pioneering role in Colombia that is so far lacking and is unlikely to occur on its own. A net-zero energy building is one that consumes no net energy from the grid over a given pre-defined period of time (i.e. monthly/annually). For this, first, the building must be designed to reduce energy demand for heating, cooling and lighting to the extent possible. Additionally, energy demand should be further reduced by use of energy efficient appliances. The remaining energy needs should then be covered by own renewable energy produced on-site. Implementing net-zero concepts to new buildings provide a useful starting point for introducing net-zero energy concepts.

The Net-Zero Energy Building (NZEB) pilot is a prospective opportunity to use international cooperation under Article 6 of the Paris Agreement to develop new net zero energy VIS and VIP residential buildings in selected cities in Colombia. Examples of zero-energy buildings are not apparent in Colombia in general and likely non-existent in the social housing sector. The NZEB pilot initiative in the social housing segment is aimed to pioneer the concept and introduce novel technologies/approaches necessary for net-zero energy in the Colombian market. Examples elsewhere show the critical role of pilots or demonstration projects in inducing market interest, promoting further uptake and creating domestic production supply chains. The NZEB pilot would be a voluntary programme that accelerates sectoral developments and informs policy measures towards the ultimate objective of mainstreaming net-zero energy housing in Colombia.

NZEBs and their role in deep decarbonisation of the residential buildings sector is currently not under consideration in either the market, policy or development cooperation circles of Colombia and the country has not yet submitted a long term decarbonisation strategy.

The technical mitigation measures to improve performance of social housing in Colombia to net-zero energy in the pilot should focus on two dimensions. First, to pilot new residential VIS, VIP housing units which are highly energy efficient in design and energy use. Second, include renewable electricity technologies such as solar panels and solar heated hot-water to compensate for residual energy demand over a monthly/annual cycle. Based on the energy consumption profile of the sector and measures discussed in ongoing initiatives, the following broad measures would need to be considered for a net-zero energy house:

1. **Passive measures** – Passive measures have to do with the civil-architectural aspects of the design of buildings. These characteristics determine the manner, form and details of the building envelope that are directly related to its energy efficiency. Some examples of mandatory passive measures that can be included are:

    c) Natural lighting through facades and/or skies;

    d) Natural ventilation to reduce a building's energy consumption load;

    e) Building orientation to reduce heating/cooling load; and

f) Building insulation. Building insulation is measured as U-value of outer walls, roof and windows. U-value provides an assessment of the level of insulation in the building. The best insulating materials have a U-value of close to zero; the lower the better.

2. **Active Energy Efficiency measures** – These deal with the equipment installed or that would be sold with the housing unit for heating/cooling, cooking, lighting etc. and deal with improving energy efficiency of equipment to reduce a building's energy demand. Active measures include those for:

    g) Lighting – e.g. LEDs for interiors, LEDs for outdoors and occupancy controls in corridors and exteriors. The penetration of LED lighting was slower in low-income strata houses (UPME, 2017) however this is likely to have changed with recent price developments of cheaper LEDs.

    h) Appliances – This relates to use of energy efficient appliance in a house, e.g. refrigeration, ironing, television, cooking appliances, computers, etc. This however represents a challenge because VIS/VIP houses are sold without appliances. Selling VIS / VIP housing units with appliance would increase the cost of the housing which would pose a challenge considering price caps for these housing units. One option to overcome this challenge is through an ESCO model, where a service provider would own the appliances and rent them to residents.

3. **Fuel switch from natural gas to electricity for cooking** – Currently, 50% of energy use in Colombian urban households is from cooking. Natural gas is the main cooking fuel, followed by a small proportion of LPG and electricity. Shifting from natural gas to power as the cooking source is necessary for achieving the net-zero energy status. To maximise efficient energy use, highly efficient stoves, such as induction stovetops, which cook with up to 90% efficiency should be promoted (Sadhu, Pal, Bandyopadhyay, & Sinha, 2010).

4. **Installation of low-carbon energy generation technologies.** Two critical technologies towards net-zero house in this region are:

    i) Solar Water Heaters (SWH) to meet the thermal energy load for hot water

    j) On-site solar PV for meeting the remaining power demand of an energy efficient house.

Cost estimates for a NZEB in comparison to a normal building complying with the requirements under Resolution 549 are as yet unclear. Although cost implications for Resolution 549, even for measures that were made voluntary for construction companies were expected to be lower than 2% of the total price of the house. Improvements are likely not feasible at current Clean Development Mechanism (CDM) market prices.

For the net-zero energy pilot approach, we propose setting crediting baseline benchmarks, based on a revised Resolution 549. This benchmark will go beyond common practice performance. The difference between the common practice and Crediting baseline benchmark can be used to identify a contribution from the pilot towards Colombia's NDC. The benchmark can be further adjusted to deliver a 'net-mitigation contribution'.

As part of the Net-Zero energy pilot, an "***ambition trigger***" would be set so that participants in the pilot would have to reach net-zero energy status before receiving credits. The ambition trigger is set so as to demonstrate a path towards decarbonisation of the sector in line with the Paris Agreement. Although a building that represents a marginal improvement beyond the revised benchmark established by the measures required by a revised Resolution 549 would reduce

emissions, any residual emissions would be locked in until a future retrofit of the building. The added "ambition trigger" provides incentive to build more efficiently is provided by the fact that credits are only issued when a project reaches NZEB status.

Mandatory building energy performance standards (MBEPS) are the centerpiece of regulatory policies in the building sector: The need for such a measure cannot completely be replaced through a market-based approach. Minimum energy performance requirements for new buildings can be incorporated in existing building codes or developed as standalone mandatory building energy codes. MBEPS typically cover minimum standards for overall energy performance of a building (e.g. energy use per unit area). This energy performance calculation typically includes elements of the building envelope such as architectural design, natural lighting etc. and some appliances (internal heating/cooling, hot water, lighting etc.).

Building energy codes are increasingly moving away from prescriptive to performance or outcome-based design. Prescriptive energy codes, as the name suggests, prescribes the approach builders should take in order to achieve the mandated energy efficiency targets. While prescriptive codes have the advantage of being structured, simple and easy to verify; over stringent prescription of measures can be seen as a barrier to flexibility, innovation and cost-optimisation for the market players. Furthermore, prescriptive codes need regular revision to catch-up with rapid market movements in energy efficiency and renewable energy. Keeping up with the market also entails substantive administrative baggage for regulators.

Many countries with experience in building energy efficiency policies have moved away from a prescriptive approach of defining "what to do to reach a goal" into a performance-based approach, where the regulator defines only the objectives and performance metrics to reach it.

Overall, to respond to the future needs of the sector and reduce energy consumption and emissions, while charting a pathway consistent with the Paris Agreement and reducing expensive government subsidy payments, we make the following recommendations:

11. **Develop a long-term target and strategy for net-zero energy for buildings as part of a long-term decarbonisation strategy.**

    a) Such a target could be set by the National Economic and Social Policy Council (CONPES), including a scale that can depict and ratchet towards net-zero energy. Such planning should take into consideration the freed up financial resources that would otherwise have gone towards energy consumption subsidies.

    b) Such a target should focus on new buildings first to avoid high energy and emissions lock in, to be accompanied by efforts to improve the energy efficiency of existing building stock through retrofits and other energy efficiency measures such as appliance standards.

12. Start small and scale up

    a) Colombia, together with ambitious international partners could consider a NZEB pilot to demonstrate innovative business models and best available technologies, reward early movers, and push improved practice penetration.

13. **Address urbanisation trends by focussing on regions with rapid population growth, including social housing demand**

    a) The Bogota metropolitan area, Medellin, and Cali are likely to represent the vast majority of population growth and construction. These municipal governments have comparatively good capacity for climate policy action, have the political will, and are already undertaking measures to reduce emissions from building stock, such as through the BEA program. The focus of energy efficiency efforts should be focussed in these cities.

b) In a second step, ambitious medium size cities could be added to capacity building efforts, potentially in partnership with already trained colleagues from the larger metropolitan areas.

14. **Update and reform the sustainable construction guide**

a) Although the sustainable construction guide is currently voluntary for social housing, the associated costs of many of the energy efficiency measures have come down since the guide was first published. A reform and optimisation of existing practices and technologies can lead to substantial reductions in energy consumption; this can be achieved without further national or international support. Capacity development and the provision of tools to facilitate compliance can help stakeholders to comply with reformed mandates.

b) Even for buildings built in the next few years that do not include the renewable energy generation on site (PV and solar hot water heaters), building designs should begin to require roofs that can easily accommodate future installation of such technology. This is a low-cost way to facilitate future measures to move towards a decarbonised building sector.

c) Increase flexibility. Moving from a prescriptive list of technologies to an efficiency standard leads to higher savings. Such flexibility reduces administrative burden and allows developers to quickly innovate and react to new technologies and approaches.

d) Simplify: Baseline setting for sectors is challenging and can become rapidly outdated. Measurement of energy efficiency in the housing sector should shift from a '% and measures' approach to 'absolute minimum energy consumption (energy/square meters)'.

15. **Define a robust compliance regime**

a) Adherence with energy efficiency regulations should be integrated into the POTs of municipalities. These should mandate regular data collection to check compliance, synergies can be found with government planning for the installation of smart meters throughout Colombia by 2030.

b) Define a clear way to show compliance with resolution 549 - develop own certification tool or adopt an existing one (EDGE, LEED, others), and train / equip curadores to check compliance through on-site verification.

16. **Go beyond building design policies**

a) Mandatory and regularly updated minimum energy performance standards can further aid the transition especially for appliances and lighting. This can be accompanied with policies that Colombia already has experience with such as the phase-out of inefficient products as in the case of incandescent light bulbs.

b) Colombia has recently implemented regulations governing net-metering. Further promotion of on-site solar thermal and PV in homes for home owners/tenants can further improve the emissions profile of the Colombian building sector.

c) Develop targeted policies to electrify for cooking and water heating, to reduce natural gas use and demand.

17. **Provide incentives to go beyond minimum requirements**

a) Instruments of ‚recognition', can provide a motivation to go beyond minimum mandated standards, these can include housing labels / stretch standards and competitions and awards (for net-zero demonstration buildings).

b) Incentivise more ambitious developers. Such incentives could include preferential interest rates from local banks for very energy efficient houses beyond the current Bancolombia and

Davivienda programmes; reduced VAT rates, and or prioritisation for construction permits. Link incentives to housing labels, stretch codes, certificates that go beyond res. 549.

18. **Explore a role for ESCOs for the residential sector**

    a) Such support could include policy support e.g. VAT exemption, subsidised loans or programmes to encourage ESCO collaboration with construction companies.

19. **Improve coordination and exchange between stakeholders**

    a) Alignment between ministries roles and responsibilities for example through special task forces that include a number of different relevant government agencies for example the Environment Ministry, the Energy Ministry and Housing Ministry, and local governments.

20. **Build new capacities**

    a) Formalise regulatory roles - who plans, who coordinates, who implements, who monitors, who verifies, who reviews, who enforces.

    b) Concentrated effort to build capacity of local governments to integrate energy efficiency and distributed renewable energy generation standards into local planning regulation (their Plan de ordenamiento territorial or POT), as well increase enforcement capacities.

    c) Train and expand the number of certified building inspection engineers.

The building sector and the social housing sector in particular, while not a major emitter, is an important sector for further action both in terms of the needs of the growing urban population in Colombia and in order to reach commitments under the Paris Agreement in the context of sustainable development. Through Article 6 of the Paris Agreement, countries can cooperate in implementing their NDCs to allow for higher climate ambition. Given the dynamic nature of the sector, ensuring environmental integrity through an overall sectoral approach to Article 6 transfers is likely to be challenging especially in terms of additionality, baseline setting, and monitoring reporting and verification. However, an Article 6 pilot approach based on Net Zero Energy Buildings in the social housing sector, could reduce energy consumption, reduce emissions, reduce energy poverty, reduce energy consumption subsidy payments, and improve public health and energy security. Such a Net Zero Energy Building pilot as part of a larger policy roadmap towards increasingly stringent energy efficiency standards, help put the Colombian building sector on a path towards decarbonisation and alignment with the Paris Agreement.

1 Introduction

Globally, buildings were responsible for 9.18 giga tonnes of greenhouse gas emissions or 19% of global emissions in 2010[2] (Lucon et al., 2014). Especially in developing and emerging economies, rapidly growing and urbanising urban populations will require a large increase of housing and infrastructure expansion. At the same time, radical improvement of the building sector is an urgent challenge that must be overcome in order to meet the temperature objectives of the Paris Agreement. Though the challenge is large, much of this can be done at low or even at negative costs (Lucon et al., 2014). For the building sector this means that to limit global warming to 2 degrees Celsius, global emissions from the building sector need to fall by 77% by 2050 compared to 2010; to limit global warming to 1.5 degrees Celsius, emissions need to fall by up to 90% (Climate Action Tracker, 2016a).

Colombia is no exception to the global trend. With economic opportunity concentrated in urban areas, Colombia also faces challenges of rapid urban growth and an associated housing shortage. At the same time, Colombia must address these needs while meeting its commitments under the Paris Agreement. As new OECD member, this means Colombia must rapidly move towards rapid decarbonisation of the building sector, both for new buildings and the existing building stock (Climate Action Tracker, 2016a). In addition to domestic efforts, international cooperation may present options to steer the Colombian building sector towards a more climate compatible and sustainable growth. International cooperation can take place through international climate finance and possibly also through the opportunities presented through Article 6 of the Paris Agreement.

The Paris Agreement marks a new milestone in the fight against climate change, particularly with regard to the development that all parties have agreed to contribute to the global effort to reduce GHG emissions. Article 6 of the Paris Agreement includes provisions for international cooperation through market mechanisms, most notably Article 6.2 which provides for cooperative approaches; and Article 6.4 for a new mechanism to promote mitigation and sustainable development. International rules governing Article 6 are currently the subject of intense negotiations in the United Nations Framework Convention on Climate Change (UNFCCC).

Colombia has a long track record in ambitious climate change planning and policy making. It has demonstrated regional leadership with regard to a number of climate measures, including the development and implementation of domestic and international carbon pricing and market-based instruments. Colombia introduced a carbon tax of approximately $5 per tonne CO_2 through a policy reform in 2016, which came into effect in January 2017. It was also relatively successful as a host country for projects developed under the Clean Development Mechanism (CDM) and shows a high-level of engagement under World Bank's Partnership of Market Readiness (PMR) programme on carbon pricing.

Colombia submitted its Intended Nationally Determined Contribution (INDC) in September 2015. The INDC provides for an unconditional, single year target of 20% emission reduction across all sectors by 2030 compared to a business as usual (BAU) scenario. Colombia has said they may increase the target to 30% with international support. The INDC notes the option to use market-based mechanisms – in line with principles of transparency and environmental integrity – for the achievement of its emission reduction target.

Article 6 could potentially provide an avenue for international cooperation on a sectoral basis to enhance mitigation efforts. The concept of sectoral approaches has historical precedence in the

[2] Excluding agriculture, forestry, and land use (AFOLU)

Bali Action Plan, which was adopted at COP13 in 2007. Proposals made in this context included ideas for a sectoral CDM, a sectoral crediting mechanism based on no-lose targets, and emissions trading based on sectoral targets. However, none of these have any consensus in current negotiations.

This report focuses on exploring options for sectoral GHG mitigation in Colombia's residential building sector with a focus on social housing and how to move the sector towards deep decarbonisation. We focus on the operational emissions in the sector, including both direct emissions (e.g. from cooking, heating) and indirect emissions (e.g. electricity use). Embedded emissions of materials and in the construction of the house, as well as household appliances are not considered, although future research must assess impacts and mitigation options from a lifecycle point of view. Emissions from leakage of refrigerants are also an important source of greenhouse gasses from the residential sector but are not a focus of this study, considering an ongoing NAMA activity focussing on the issue.

We discuss the financial aspects of various measures, their potential impact, financing options, as well as the potential options and trade-offs of using reductions for domestic efforts for the Colombian INDC or transferring generated credits towards commitments under the Paris Agreement. It is a conceptual study that covers selected aspects relevant for ambitious emission reductions in Colombia's building sector, looking, in particular, at benchmarks and their potential in market-based and market-compatible approaches, including barriers to such an approach and circumstances under which such an approach would make sense. In the building sector, benchmarks are traditionally used as indicators of (energy) performance of buildings.

Colombia continues to face a deficit of affordable housing for lower income groups. Tens of thousands of new housing units must be built with limited fiscal resources. At the same time, the building sector in Colombia, as elsewhere, presents a number of challenges for energy efficiency measures in general and especially for emission reduction crediting. These include, inter alia, a large number of stakeholders involved; fragmented market and institutional structures; challenges of enforcing existing building guidelines; high heterogeneity with vast variances in building practices through time. These are related to, cultural aspects and cognitive and behavioural patterns that differ between geographic regions and between construction firms. A large number of measures would lead to fairly limited emissions savings given the relatively low emission electricity grid in Colombia. Other challenges include transaction costs; long investment payback periods; limited capital / access to financing; risk aversion; distorted tax regimes and energy consumption subsidies; patents and barriers to technology transfer; and a lack of information and awareness that hinder investments to be made. Further monitoring and verification of energy performance and energy performance improvement pose challenges as well as high transaction costs (Lucon et al., 2014).

These challenges made project-based crediting in the building sector impracticable in the CDM, both in Colombia and around the world. Most CDM projects in the household energy efficiency area concentrated on single interventions such as light bulb replacement or cookstoves but failed to bring about a transformational shift towards efficient building practices. A sectoral approach may address some of these barriers but still presents a major challenge.

Further research into policy approaches to drive emission reductions in the building sector however make sense for two reasons:

- There is an untapped global potential for cost-effective mitigation in the building sector. According to the IPCC 2014 Assessment Report, the building sector offers the opportunity to hold final energy use constant or even decline by mid-century, as compared to today's levels, or a possible

double or tripling in business as usual cases. This can be done purely with a broad diffusion of today's cost-effective best practices and technologies (Lucon et al., 2014). Approximately 30% of all buildings-related emissions can be avoided at low cost by 2020 (Levine et al., 2007). Increased energy efficiency in the building sector is typically associated with economic gains and with positive short- to medium-term returns on investment. Many opportunities for cost savings such that low-energy buildings can often be delivered at no extra cost. (Torcellini & Pless, 2012)

- The modernisation of energy access and energy efficiency in the building sector usually holds major synergies with other development objectives / co-benefits, including poverty alleviation, improved health, quality of life, employment creation, energy security, and facilitating parallel progress on a country's climate and development agenda.

This study is carried out on behalf of the German emission trading authority (DEHSt) at the Federal Environment Agency (UBA) which receives funding from the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). DEHSt at UBA is the German Designated National Authority (DNA) in charge of implementing the flexibility mechanisms under the Kyoto Protocol, and also works continuously on the development of domestic and international market-based approaches in Germany and its partner countries. Since the building sector is complex in many regards (e.g. regarding owner structures, emission sources, monitoring, etc.), progress has been slow and the building sector is comparatively under explored in terms of mitigation policy research for markets or as a specific area of intervention in NDCs. The research presented here aims explore the challenge of increasing the energy efficiency of buildings in general, with a focus on social housing and proposes an innovative, ambition focused approach to promote Net Zero Energy Buildings in the social housing sector, along with a more comprehensive policy package for buildings in general.

The study is undertaken in close cooperation and collaboration with Colombian national stakeholders, including the government and other relevant actors and sector experts. Project activities fit well with Colombia's engagement in international market negotiations and its efforts to develop carbon pricing and market-based instruments also at the domestic level. Technical assistance under the project involves a detailed analysis of the status quo, the mitigation potential, and costs and options for reducing greenhouse gas (GHG) emissions in the building sector and its subsectors. This information can be of use to the country in the development of its broader climate and energy strategies, and can support the translation of the NDC into sectoral targets and related measures, particularly in the building sector. Project activities can furthermore advance the agenda for the modernisation of the building sector with significant implications for related national development objectives.

The report is structured as follows: in the next section we review of Colombia's climate policy and plans for NDC implementation (Section 2) followed by a discussion of current mitigation activities in the building sector (Section 3). Subsequently, two further sections explore the potential of a market-based intervention through Article 6 of the Paris Agreement to incentivise further mitigation activity in the building sector (Section 4) and an overall discussion of policies required to put the sector on a path towards decarbonisation (Section 5). We then investigate how to incorporate, harmonise, and maximise synergies of both a potential market-based intervention with a larger policy reform to drive ambitious emissions reductions in the building sector are then explored (Section 6). A final section summarises the findings and provides general recommendations and key messages (Section 7).

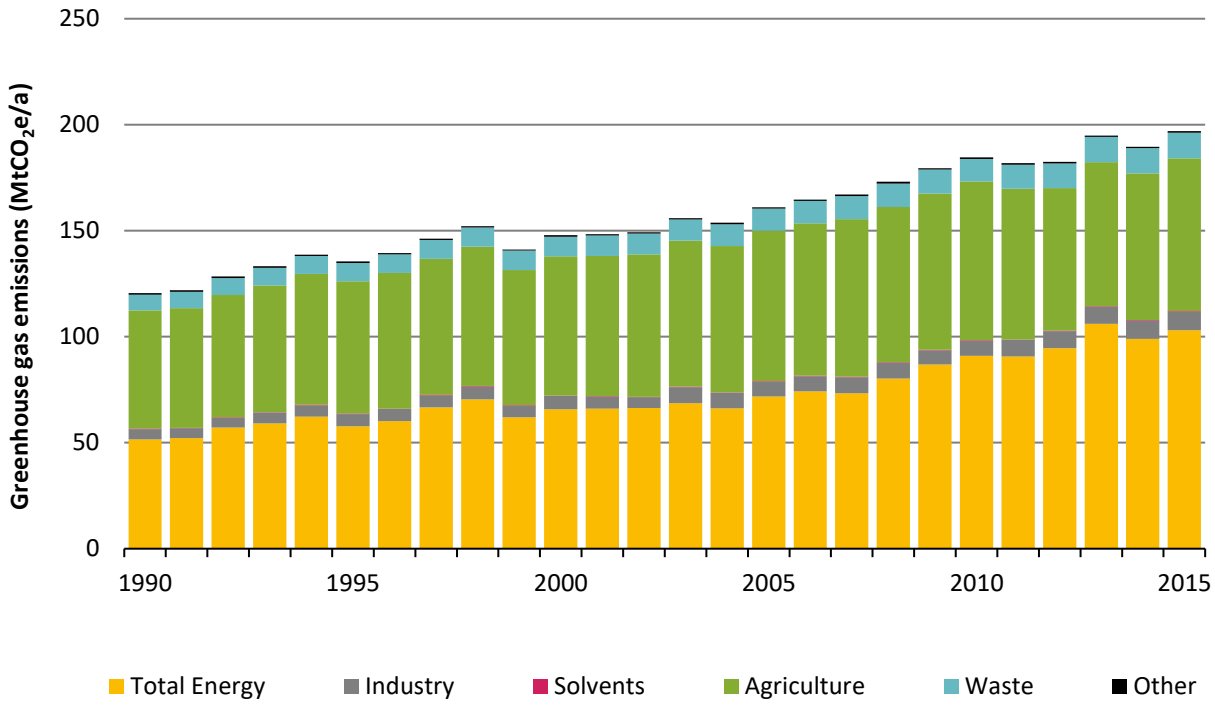
2 Colombian Climate Change Policy

This section provides an overview of Colombia's emission profile and likely trends in emissions. We then review Colombia's climate change policy on the national level for an understanding of how government efforts affect various sectors including how the government expects to finance these policies and what role carbon pricing will play in NDC implementation. This will set the stage for an investigation of how the building sector fits into the overall picture and what could be done in this context to reduce emissions in the building, and specifically the social housing sector.

2.1 Emissions Profile and Trends

With emissions of 162.87 $MtCO_2e$ (excluding LULUCF) in 2014, Colombia is the fifth biggest emitter in Latin America after Brazil, Mexico, Argentina, and Venezuela (WRI, 2014). Emissions have also consistently grown along with economic growth since 1990 (ibid). The energy sector is the largest source of emissions (excluding LULUCF). Therein, transport sub-sector is the most emission-intensive. Buildings consume a fifth of the total energy use in Colombia and after transport and industry are an important energy end-user (Government of Colombia, 2013)

Figure 1: Colombia's historical GHG Emissions by sector (excluding Land-Use Change and Forestry)



Source: NewClimate database. Primary data from (Gütschow, Jeffery, Gieseke, & Gebel, 2018)

Different models, the TIAM-ECN and GCAM, two integrated assessment partial equilibrium models; and Phoenix and MEG4C, two general equilibrium models, predict a business-as-usual (BAU) scenario where Colombian emissions increase through 2050 (Calderón et al., 2016). Breaking the overall emissions down into its components based on the Kaya identity (population, GDP per

capita, energy intensity of GDP, and carbon intensity of energy) provides insights into trends and opportunities for policy intervention in Colombia to achieve the NDC and steer the economy to a low carbon path.

- Although Colombia's population growth has continually been slowing since 1990 and was around 0.9% in 2016 (World Bank Data 2018), the models mentioned above all expect continued growth through 2050 (ibid). Such growth is however not evenly distributed in Colombia which, like many Latin American countries, is experiencing rapid urbanisation, with most growth concentrated in Bogota and other cities of between 1 and 5 million people (UNDESA, 2018).

- Economic growth has continued in 2018 at a rate of 2.2% in the first quarter over the previous year (Alemán, 2018). A stable environment for continued economic growth is expected to increase demand for energy consumption. Although consistent with historic trends, three of the four models predict a falling energy intensity of GDP over time, a common trend in countries as they shift towards a service-based economy. Calderón et al. highlight energy efficiency potential to improve this trend (Calderón et al., 2014).

- Changes in the energy mix determine the carbon intensity of energy over time. Because hydropower has little potential for expansion in Colombia, given expected increased demand[3], the future carbon intensity of energy will be influenced by decisions to invest in fossil fuels or renewable energy.

Colombian climate and energy policy will be important to address emissions growth over time. Promoting renewable energy can improve the carbon intensity of energy, and especially relevant for this report, improvement in energy efficiency will help to reduce the energy intensity of GDP. Without further policy intervention, these factors are likely to lead to a substantial increase in emissions from the building sector.

2.2 Colombian Climate Change Policy and Institutional Framework

Colombia ratified the UNFCCC in 1994 as a non-annex 1 country with no commitments and ratified the Kyoto Protocol in 2000.

In 2002, the Ministry of Environment and the National Planning Department (DNP) issued the Colombian “Guidelines for Climate Change Policy”. It outlined the likely impact of climate change on Colombia and what Colombia needed to do to comply with international obligations under the UNFCCC and the Kyoto Protocol.

At COP 15 in Copenhagen in 2009, Colombia made a number of unilateral and conditional pledges (Bermúdez Merizalde, 2010), including:

- Colombia committed to a minimum of 77% of renewable energy in the installed capacity of the country by 2020;

- With financial support, Colombia pledged to reduce deforestation in the Colombian rainforest to zero by 2020; and to increase the proportion of bioethanol and biodiesel in the national fuel

[3] GCAM and Phoenix project rising carbon intensities of energy over time while TIAM-ECN and MEG4C predict declining energy intensity over time.

market to an estimated 20% also by 2020 without threatening natural forests or the food security of Colombians.

2.2.1 Institutional Strategy for Climate Change Policies and Actions

The National Economic and Social Policy Council (CONPES) whose secretariat is led by the National Planning Department has defined recent climate policy in Colombia. In 2011, the council issued "CONPES 3700 on Climate Change" which outlines the "institutional strategy for the articulation of policies and actions on the issue of climate change in Colombia". This document emphasises the importance of understanding climate change as a particular challenge to socio-economic development that requires the development of strategies at the sectoral as well as regional, and national levels. It creates a framework for sectors and regions helping them to integrate adaptation and mitigation action into their planning processes, make adequate use of resources, reduce their risk exposure, and increase their response capacity. It also creates a space for shared and coordinated management, and information that allows for effective decision making of sectoral, regional, or national actors (CONPES, 2011).

The following strategies and plans emanated from CONPES 3700:

- The Climate Change National Adaptation Plan (PNACC);
- The National Strategy on Reducing Emissions from Deforestation and Forest Degradation (EN-REDD+);
- The Strategy for Fiscal Protection Against Natural Disasters; and
- The Colombian Low Carbon Development Strategy (CLCDS).

Colombia launched its Low Carbon Development Strategy (CLCDS) in 2011. CLCDS is a long-term strategy (up to 2040) which works to decouple GHG emissions from economic growth. It comprises three key components: 1) identification and assessment of alternatives and opportunities in low-carbon development; 2) design and implementation of plans, policies and measurements in low-carbon development; and 3) design and construction of an MRV system. The Ministry of Environment cooperates with other line ministries in order to promote the design and implementation of sectoral mitigation plans (PAS) under the CLCDS.

2.2.2 The National Climate Change System (SISCLIMA) and the Inter-sectoral Climate Change Commission (CICC)

I2016, the Ministry of Environment issued Decree 298/2016 which establishes the National Climate Change System (SISCLIMA), which was earlier conceptualised in the CONPES 3700 in 2007. SISCLIMA monitors and evaluates climate change measures of public and private entities and coordinates with international actors working on climate issues in Colombia. The system includes a finance committee that looks at financing climate measures in the country (MinAmbiente, 2016).

The CICC is composed of representatives of the Ministry of Environment, Ministry of Interior, Ministry of Finance, Ministry of Agriculture, Ministry of Energy, Ministry of Transport, Ministry of Foreign Affairs, and the director of the National Planning Department. Functions performed by the CICC include: the establishment of policies and actions to achieve the Colombian climate change targets; the definition of criteria for the allocation of respective resources in the budget of each ministry; the support and formalisation of intersectoral commitments and compromises; the issuance of general instructions and solicitation of reports; the promotion of different

mechanisms between the National Government, territorial entities and the private sector that allow for a joint implementation of policies; the coordination and definition of a strategy for monitoring, evaluation and reporting on the National Climate Change Policy; and the creation of technical committees needed for the fulfilment of its functions (MinAmbiente, 2016).

2.2.3 Colombian Green Growth Strategy

Colombian Green Growth Strategy, developed as part of the Colombian application for OECD membership, is part of the National Development Plan 2014-2018. It lists efficient use of resources as an important way to increase productivity and competitiveness while reducing emissions.

2.2.4 Intended Nationally Determined Contribution (INDC)

In September 2015, Colombia submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC. As part of its INDC, Colombia established a unilateral, single year national target to reduce its GHG emissions by 20% below a business as usual (BAU) scenario (including AFOLU) by 2030 (single year target), and by 30% if international support is provided. An indicative target for 2025 is considered based on the results of COP 21.

Colombia's estimates that its 2010 emissions were 224 mega tons of CO2eq. From this point, the NDC expects a BAU emissions pathway towards 278 MtCO2e by 2020 and 335 MtCO2e in 2030. On this basis, the unconditional and conditional NDC targets translate to 268 MtCO2e and 235 MtCO2e in 2030, respectively. The technical support document for Colombia's INDC identified demand side energy efficiency opportunities as an important opportunity to reduce emissions.

Inventory data for 2012 that was recently compiled in the context of Colombia's Third National Communication suggests significantly lower BAU emissions levels through 2030 than those assumed under the BAU scenario provided in Colombia's INDC. The difference stems from a significant reduction in reported LULUCF emissions between 2010 and 2012. The harmonisation of INDC BAU projections with latest inventory data leads to reductions in BAU emissions levels in 2020 (ranging from 58 to 69 MtCO2e) and 2030 (ranging from 58 to 83 MtCO2e). These results indicate that Colombia could achieve its unconditional INDC target (268 MtCO2e in 2030) with current policies if the INDC baseline remains unchanged (PBL, forthcoming). Yet, it is not clear, at this point in time, whether the BAU scenario in Colombia's current INDC will be updated according to the new inventory data.

Despite fluctuations in the baseline related to AFOLU emissions, the national target of 20% emissions reduction is expected to be passed down equally to the sectors (i.e. 20% in each sector), focussing on the energy, housing, industry, transport, agriculture, and forestry sectors. Each line ministry will develop a plan on how to achieve the 20% reduction in the sector it is responsible for. First results were presented during the first CICC meeting end of September but have not been made public.

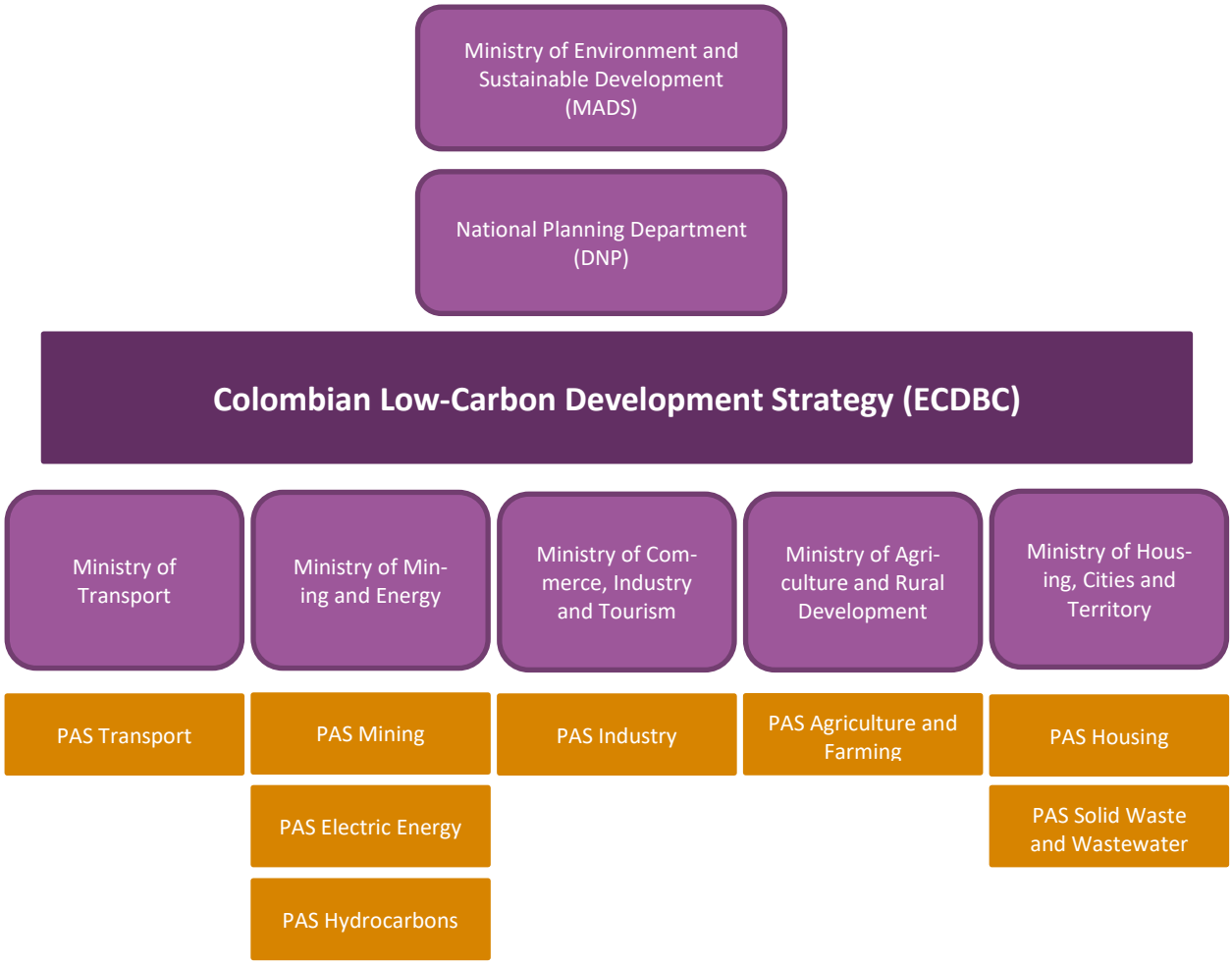
The INDC process involved a cross-sectoral participatory process where all main economic sectors, private actors, and the civil society were convened to understand the sources of GHG emissions and work together on options to reduce them. The process was embedded in the framework of the CLCDS and was aligned with other existing programmes and instruments, such as the National Plan for Climate Change Adaptation, the national REDD+ strategy, and Sectoral Action Plans that were formulated and approved by five-line ministries[4] for eight important sectors: transport, energy, mining and hydrocarbons, industry, agriculture and farming, housing,

[4] These ministries are: Ministry of Mining and Energy, Ministry of Transport, Ministry of Commerce, Industry and Tourism, Ministry of Agriculture and Rural Development, and Ministry of Housing, Cities and Territory.

and waste. The Ministry of the Environment and Sustainable Development leads the ECDBC with support of the National Planning Department. Each sectoral action plan comprises concrete mitigation options and measures for the different sectors to address their emissions. The sectoral action plans provided the data for the compilation of the INDC.

As of June 2018, no long-term decarbonisation strategy has been submitted to the UNFCCC.[5]

Figure 2: Sectoral Mitigation Action Plans of line ministries included in the Colombian Low Carbon Development Strategy



Source: (MinAmbiente, 2018b). Author's translation

To further support decision making and implementation of sectoral action in the framework of the NDC, the University of the Andes identified and analysed 101 potential mitigation measures for the eight main sectors (including the building sector, see section 3), presenting, for each measure, a factsheet with relevant quantitative and qualitative information (Universidad de los Andes, 2016).

2.2.5 National Policy on Climate Change

In June 2017, the CICC adopted the Colombian National Policy on Climate Change, which implements the INDC. The overall policy includes strategies to mainstream low carbon and resilient development at all territorial levels, and sectors inter alia mines-energy and infrastructure. It

[5] Long Term Strategies can be found here: The following link leads to the internet: https://unfccc.int/process/the-paris-agreement/long-term-strategies

contains also a number of instruments to implement the overall policy: i) information, science, and technology; ii) education and awareness; iii) planning; and iv) financial instruments. The policy not only integrates the institutional arrangement established in CONPES 3700 at the national level, but also includes territorial entities (departments and municipalities) and environmental regional authorities for coordinating adaptation and mitigation actions in the regional and local levels. The policy expands the scope of the sectorial mitigation action plans (PAS) to include sectorial adaptation actions. Therefore, currently all relevant ministries and departments are formulating integrated climate change sectoral plans and integrated climate change territorial plans, respectively.

A draft for a Climate Change Law is being developed in order to establish the necessary regulations to prevent and mitigate emissions, adapt to the impacts of climate change and promote economic, industrial, and technical progress as well as sustainable development of the country (Universidad de los Andes, 2015).

The INDC is closely aligned with the 2014-2018 National Development Plan. According to the PNCC, every new development plan should include an explicit contribution of each of the central sectors to achieve the proposed target for the respective four-year period. These contributions will provide the basis for the elaboration and actualisation of the eight existing sectoral action plans or, more specifically, the sectoral mitigation plans (MinAmbiente, 2018b).

2.2.6 National Registry of GHG Emission Reductions

In order to keep track of climate action, Article 175 of Law 1753/2015 established a National Registry of GHG emission reductions (RENARE) (Republic of Colombia, 2015). The Ministry of Environment and Sustainable Development is responsible for developing and administering the registry, which also serves to monitor progress towards the Colombian NDC.

The registry aims to serve as a platform to account for emission reductions and removals, as well as support the MRV processes at the national level including tracking NDC implementation. Article 175 further states that emission reduction accredited by the Ministry of Environment under the national or subnational mitigation programmes cannot be offered in the domestic or international carbon market.[6] Though as of June 2018, the registry has not yet been launched.

2.3 Financing NDC implementation

The SISCLIMA has a subcommittee on finance, that includes representatives of the Colombian Government, the national development banks, and the private sector. The National Planning Department serves as the committee's secretariat (Naidoo, Amin, Dimsdale, & Jaramillo, 2014). The committee holds regular session on how to finance NDC implementation. The National Planning Department leads the work, which is, in parallel, elaborating a comprehensive national climate finance strategy to support the National Climate Change Policy as well as the Climate Change Law, once adopted.

In 2016, it was estimated that implementation of the NDC will require investments of 3.1 trillion Colombian Pesos (COP) or approximately 0.92 billion EUR per year[7]. The public sector is expected to invest roughly 27%, while the private sector, mobilised through policies and measures such as efficiency standards, is expected to invest 73%. Currently, the Colombian government is making progress on INDC implementation through the identification of 1) sources for recurring

[6] Original text: ‚Las emisiones reducidas que acredite el Ministerio de Ambiente y Desarrollo Sostenible en el marco de programas nacionales o subnacionales de reducción de emisiones de GEI, no podrán ser posteriormente ofertadas a través de proyectos en el mercado.'

[7] At 3,327.35 Colombian Pesos to the Euro, exchange rate from 29 May 2018.

investments; 2) needs for new investment; 3) needs for sectoral regulation; 4) potential new economic instruments (Cancillería, 2016).

The National Planning Department elaborated a study on the broader economic impacts of the fulfilment of Colombia's commitment under the Paris Agreement. The study shows that GDP growth in the country would – after some adjustment costs in the short term – increase by an additional 0.15% annually between 2020 and 2040 in a scenario that considers mitigation measures, compared to BAU. Calculations are based on a portfolio of 71 mitigation measures (out of the 101 identified by the University of the Andes) that have a cost of less than USD 20 per tCO2e (in 2010). The unemployment rate is expected to decrease as a direct result of mitigation action in labour-intensive sectors, such as transport and agriculture. The study furthermore shows that large investments will need to be directed at the transport sector (around 72% of the total), as well as at the agricultural (16%) and residential (8%) sectors. The study further finds that transport, agriculture, and industry should be priority sectors in the implementation of the unconditional NDC, with construction (including residential), trade and services being directly affected through their interrelations with these sectors.

There are three main sources of finance that the Colombian government is mobilising for NDC implementation: public, private and international.

2.3.1 Public Finance

Germany funded the development of a Climate Public Expenditures and Institutional Review (CPEIR) for Colombia which led to an MRV system and an online portal on climate finance in Colombia[8]. According the portal, over $6 billion USD of public funds, both domestic and international, flowed to 15,000 different climate change measures in Colombia between 2011 and 2015.

The Colombian government has already mobilised sizeable resources towards NDC implementation. Between 2005-2017, the Colombian government estimates that it has spent 11,432.4 billion Colombian Pesos (3.39 billion Euros[9]) on climate change measures. In the short to medium term, future public spending on climate and NDC implementation will be determined by the government of the new conservative President Iván Duque who was elected in June 2018.

For mitigation measures with a positive future revenue stream (e.g. energy efficiency measures), green bonds can be a particularly important tool to mobilise private finance for climate mitigation. The financial management SICLIMA under the DNP has been working on further green debt market development. Moreover, E3 - Ecología, Economía y Ética, Metrix Finanzas in association with PwC-UK and the Climate Bonds Initiative, published a roadmap for a local green bonds market[10] (Climate Bonds Initiative, 2017b).

Álvarez-Espinosa et al., (2017) highlight that public investment is needed to steer private finance in the right direction, through the creation of de-risking instruments, incentive schemes, co-investment opportunities, and other measures. Importantly, green bonds issued by public actors have started to become an important vehicle in the mobilisation of private finance for climate mitigation and have the potential to play a growing role in the implementation of NDC.

An important potential measure that the public sector can take to mobilize private capital is through public development banks. Public development banks have potential portfolios, credit

[8] The portal can be accessed at: The following link leads to the internet http://mrv.dnp.gov.co/Paginas/inicio.aspx

[9] At 3336.49 Colombian Pesos to the Euro, exchange rate from July 2018.

[10] The roadmap can be found at: The following link leads to the internet https://cdkn.org/resource/guide-road-map-actions-setting-green-bond-market-colombia/?loclang=en_gb

ratings, and capacity to issue green bonds. These banks include Findeter, Bancoldex, Financiera del Desarrollo Nacional and FINAGRO.

Findeter in particular is considered to have potential to aggregate projects and assets of municipalities that may be too small or lack capacity to float their own green bonds. Findeter has assets that could be considered eligible for a green bond of $138 million US Dollars (118.69 million Euros[11]) and green projects account for $1,259 million US Dollars (Martinez Zuleta et al., 2017).

Furthermore, in August 2017, Bancóldex, Colombia's public "entrepreneurial development bank" under the Ministry of Industry and Tourism, floated a green bond of 200 billion Colombian pesos for climate mitigation. The auction was significantly oversubscribed, with a demand of 510 billion pesos. The IDB, with resources from the Secretariat of State for Economic Affairs of Switzerland (SECO), supported bond structuring (IDB, 2017).

A number of sub-national governments also have sufficient capacity and balance sheets to be able to float green bonds. These include: Barranquilla and Bucaramanga, the Provinces of Atlántico, Antioquia, Cundinamarca, Santander, and Bogotá D.C. (Martinez Zuleta et al., 2017). A number of these cities have further made investments in assets that would be eligible as a basis for green bond issuance (ibid). Municipal bonds are also something that Colombian subnational governments have some experience with: Bogota for instance floated a $100 million USD municipal bond in 2001 (IDB, 2016). Moody's revised the credit outlook of both Bogota and Medellin from negative to stable in February 2018 (Moody's, 2018). Colombia has further already tapped fixed income markets for such things as a social impact bond to finance employment and poverty alleviation measures (Gustafsson-Wright & Boggild-Jones, 2017)

2.3.2 Private Finance

In addition to the efforts of public entities to mobilise finance for the NDC, the Colombian private sector has also already started to realise its potential and the business opportunity to raise capital and invest in climate friendly businesses. Colombia's finance sector is considered mature with a credit rating of BBB from Fitch, a stable outlook, and a national long term rating of AAA(col) (Fitch, 2017). Colombia also has a developed private equity fund sector, private pension funds, and a stock market: the Bolsa de Valores de Colombia. Colombia is successful in attracting foreign investment with 13.5 billion USD in FDI in 2016 (Santander, 2018). However, compared to other countries in the region, the Colombian private bond market remains somewhat underdeveloped – the national government is the leading issuer with 82.9% of the country's debt market (Martinez Zuleta et al., 2017).

Domestic pension funds are an important potential investor in Colombian Green bonds (Martinez Zuleta et al., 2017) and private Colombian pension fund assets represented roughly $79.8 billion in March 2017 (Sitori-Cortina, 2017).

There have already been two private sector green bond issuances. In December 2016, Bancolombia issued the first green bond from Colombia (115 million USD)(Patzdorf, 2016); Davivienda bank followed in April 2017 an issuance of COP433bn (149 million USD)[12]

Colombia further has a number of private domestic philanthropic foundations that fund measures related to climate change and sustainable development, most notably the Fundación

[11] At 1.16 Dollars to the Euro exchange rate from July 2018

[12] The capital raised from the green bonds, goes in part to finance promotional rates for construction companies building energy efficient buildings and for mortgages of buyers who buy energy efficient housing. Further details are in the next section under "Financial incentives for mitigation in the Colombian building sector".

Mario Santo Domingo Por el Desarrollo Sostenible de Colombia and the Fundación Grupo Familia.

2.3.3 International Development Finance

According to the Climate Funds Update, Colombia had received approximately 209 million USD for mitigation measures alone from major international climate finance funding institutions as of 1 March 2018 (ODI, 2018). This amount is in line with or exceeding the amount of funding comparable countries in Latin America received.

International funding has been disbursed through:

- Five supported Colombian NAMAs;
- Three projects of the Clean Technology Fund;
- Fast Start Funds from Japan for adaptation;
- Six German International Climate Initiative projects;
- Two Adaptation Fund projects;
- Funding from the World Bank's Forest Carbon Partnership Facility;
- Eleven projects funded by the Global Environment Facility;
- Support from the World Bank's Partnership for Market Readiness;
- Grants from the German Climate Finance Readiness Programme.

There are many foreign organisations and programmes currently active in Colombia in the field of climate change.

2.4 Status of Carbon Pricing in Colombia

Carbon pricing can help steer private capital towards more climate friendly investment and raise finance for climate mitigation measures. Colombia has shown interest in carbon market-based activities and instruments. CDM projects in Colombia date back to January 2006. Colombia's NDC states that it "will explore the use of market instruments (or other economic instruments)", as a means to achieve its NDC target. Such instruments should "guarantee the principles of transparency and environmental integrity, which result in real, permanent, additional, and verified mitigation outcomes and prevent double counting" (Colombia 2015).

2.4.1 Experience with Project and Programme-based Market Mechanisms

Clean Development Mechanism (CDM). The Colombian government published a national CDM implementation strategy in 2000 identifying likely key target sectors for CDM interventions (National Strategy Studies, 2000). In 2002, the year after the Marrakech Accords, Colombia established the Colombian Office for Climate Change Mitigation, to promote CDM projects in in the country. The first CDM project in Colombia was registered in January 2006, and the first credit was issued in 2007. In terms of the number of registered projects, Colombia comes after Brazil, Mexico, and Chile in Latin America. CDM project development in Colombia was in line with regional trends in Latin America and Caribbean. CDM related activities include 75 listed projects (64 registered and rest in validation) and four programmes of activities (UNFCCC, 2018).

Projects from Colombia mostly fall under the project types hydro (23 projects and one POA) and landfill gas (19 projects and one PoA). A PoA focussing on energy efficiency by equipment replacement in commercial, industrial, and public buildings was initiated in Colombia, but was withdrawn during the validation stage. According to the UNFCCC CDM project database, Colombia has 68 projects registered with the potential to issue 60 million CERs (Certified Emission Reductions) over the period from 2013-2020. However, only 25 of these projects have been issued with CERs to date, amounting to 3.67 million CERs in total (11.5 million in total during the second Kyoto commitment period). The relatively low issuance numbers are likely a result of the market conditions for CERs, which have provided limited financial incentives for projects since 2012.

NewClimate Institute carried out an extensive survey of registered CDM projects in 2014-2015 to examine their status and outlook (Warnecke, Day, & Klein, 2015). Analysis, based on the survey findings, suggests that the registered projects and PoAs in Colombia may deliver approximately 24MtCO2 of monitored emission reductions over the period 2013-2020, or slightly less than half the level envisaged in PDDs (Schneider, Day, La Hoz Theuer, & Warnecke, 2017).

Voluntary carbon markets. Colombia has a comparatively buoyant voluntary carbon market. More than 800,000 verified emission reductions (VERs) have been generated under the voluntary certification standard VCS and more than 200,000 under the Gold Standard (GS). Many other projects under implementation using VCS, GS, and Plan Vivo in Colombia. Transaction volumes amounted to 135.6 KtCO2e in 2016 at an average price of $6.20 (Hamrick & Gallant, 2017).

To support the development of a market for Colombian VERs, a **Voluntary Mitigation Mechanism (MVC)** was launched in August 2016 by a local civil society organisation, Fundación Natura, with support of the Ministry of Environment and Sustainable Development (*Ministerio de Ambiente y Desarrollo Sostenible,* MinAmbiente). The initiative includes a development of a VER transaction platform and registry. However, the initiative has been dormant since the carbon tax with offsetting provisions and a national registry (developed by the Ministry of Environment) was rolled out.

The initiative has focussed on forestry, agroforestry, and REDD+ projects so far. But the administering organisations foresee expanding into energy efficiency and alternative energies, waste management, and other project types as well in future (Fundación Natura 2016, Bolsa Mercantil de Colombia 2016).

2.4.2 Current Domestic Carbon Pricing Approaches

2.4.2.1 Activities under the World Bank's Partnership for Market Readiness (PMR)

Colombian policy makers are also exploring the role of carbon pricing instruments, with the support of international initiatives such as the World Bank's Partnership for Market Readiness (PMR) initiative. Colombia's Market Readiness Proposal under World Bank's PMR programme was approved in 2014 and the implementation funding was disbursed the same year (PMR, 2016). In early 2017, the government launched a carbon tax, with a provision to offset tax obligations up to a maximum of 100% through domestically generated emission reduction credits.

The PMR has funded research on role and efficacy of various carbon pricing instruments in the Colombian context. The ongoing research includes studies on the feasibility of an ETS and on macro-economic assessment of price-based instruments to implement national emissions reductions. Both studies are carried out in close cooperation with the National Planning Department (DNP) and the Ministry of Environment.[13]

[13] Based on interview with PMR representative (December 2017).

2.4.2.2 Carbon Tax and Provision for Use of Offsets

Another initiative aimed towards achieving Colombia's NDC targets is the national carbon tax. The carbon tax policy design highlights the Colombian government's interest in promoting the private sector's role in mitigation. Colombia's carbon tax of COP 15,000/tCO_2 (approximately 5 USD/tCO2) came into effect on 1 January 2017, through Law 1819 of 2016. The tax covers all liquid and gaseous fossil fuels for the purpose of combustion and is levied based on the carbon content of the fuel. Tax payers are those major distributors that buy fossil fuels, from the producer (primarily Ecopetrol, the largest petroleum producer in Colombia) or the importer. A producer or importer pay the tax themselves if they use fuel for their own consumption. The tax amount is calculated at the point of sale of the fuel to the major distributors, and they increase the fuel price downstream to the final consumers. Gas for electricity production as well as fuel for the international aviation and shipping sectors are excluded from the tax's coverage.

The revenue raised through the tax is already earmarked for the multi-million dollar 'Fund for a Sustainable Colombia'. The Fund includes four sub-funds, each supported and managed by different donors, including the World Bank, the Inter-American Development Bank (IDB), the EU, and the UN, and aims to support territories where challenges of armed conflict, rural poverty, regional development gaps, vulnerability to climate change, and deforestation overlap. The fund has received its first tranche of funding of 100 million USD from IDB in February 2017 (Dinero, 2017). In May 2018, the Colombian government announced that the carbon tax will be allocated as follows: 25% of the carbon tax to environmental goals (including climate change), 5% to increase protected areas, 70% to implement the peace agreements. (MinAmbiente, 2018a).

Offsetting Provisions in Colombia's carbon tax. In a supplementary ruling in March 2017 (Carbon Tax General Ruling 03259), the National Tax Authority (DIAN) identified that 'carbon neutral' taxpayers will be exempt from the tax and offsets could be used to alleviate the tax liabilities, but no details were provided (EY, 2017). Further clarity on the specifics of the offsetting provision in the carbon tax were disclosed in a supporting regulation in June 2017. Decree 926 further elaborates that the term 'carbon neutral' must be understood as neutralising the GHG emissions arising from fuel use, for which the carbon tax is levied[14] (Ministry of Finance and Public Credit, 2017). In other words, fuels consumers can reduce the prices of the fuel by transferring carbon credits to the major distributors to offset the carbon tax, however given the transaction costs, in practice only large companies opt to use the offsetting option. International offsets were allowed for the period between June and December 2017. In the first 6 months, the tax exemption mechanism was used to offset close to 5 million tonnes of emissions, equalling about 75 billion Colombian pesos (or 25 million USD) of avoided tax[15].

The decree goes in depth into procedural details of using offsets to mitigate the tax liability of obligated entities, described as follows:

- **Proof of carbon neutrality**: The taxable person must certify that they reduced their tax obligation through offset purchases by providing a request for non-causation of emissions to the implementing agency. This request must be accompanied by:

[14] Original text: '*Carbono neutro. Se entiende por carbono neutro la neutralización de las emisiones de GEl asociadas al uso del combustible sobre el cual no se causará el impuesto nacional al carbono*'

[15] MADS Presentation at Stakeholder Workshop in Bogota 15 March 2018.

- A verification certificate provided by a verification body. The certificate must include the details of the initiative where reductions were achieved as well as those of the acquirer of the offsets; and the verification methodology implemented by the initiative (Article 1.5.5.5); and
- Supporting evidence towards the voluntary cancellation[16]. This must include a certificate from the certifying agency/standard (e.g. CDM EB, VCS, Gold standard) stating the emission reductions have been cancelled towards the carbon tax obligations (including their serial number); a copy of the status report of the used reductions from the National Registry of GHG emission reductions; and details of the provider and acquirer of offsets (Article 1.5.5.4).

- **Eligible offsets:** The initiative resulting in emission reductions or removals of GHGs must be developed within Colombia and after 1 January 2010. Until the end of 2017, offsets generated from activities outside Colombia were also eligible in the scheme. In addition to CERs from Colombian projects, only ex-post (verified) credits generated from voluntary initiatives, i.e. those beyond an existing governmental mandate, are eligible as offsets. Only domestic offsets (emission reductions generated in Colombia) are eligible after 31 December 2017.
- **Eligible standards and methods:** The certification standard or programme that formulates and implements the initiative which results in offsets must have a public registry platform for transparency. The emission reductions or removals of GHGs used for offsetting carbon tax obligations should be cancelled by the certification programme or standard issuing it (and issue a voluntary cancellation certificate) and must be registered in the National Registry of Emissions Reductions.
- **Eligible methodologies** include those developed under the CDM, or others which have undergone a public consultation and are verified by accredited agencies. Emission reductions units issued by voluntary certification programmes that comply with verification procedures under ISO 14064-2: 2006 and those defined in the decree (see next point) and REDD+ are accepted as offsets.
- **Eligible verification agencies:** Verification agencies accredited either by the UNFCCC, Colombia's National Accreditation Body, or a member of the International Accreditation Forum (IAF) that has accreditation services for greenhouse gases under ISO 14065 can serve as verification agencies for the carbon tax (Article 2.2.11.1.1 – 2.2.11.1.3).

2.4.3 Emission Trading

With support from the PMR, Colombia is also exploring the potential of using an ETS, which could include the transport sector (Colombian Ministry of Transport 2016). However, according to local experts, discussions are preliminary and there is no current timeline for further steps for design or implementation. A general climate change law, proposed by the Ministry of Environment in August 2017, focussed mainly on broader climate change issues but also included provisions for a "system of tradeable emission quotas" (ICAP, 2018). The Senate approved an updated version of the law in June 2018. As of July 2018, however, it was unclear if the law would receive Presidential approval under the new government (ibid). However, interview partners during a research mission to Colombia in September 2018 confirmed the new President's support for the law.

[16] Original text: *soporte de cancelación voluntaria'*

2.4.4 Other Market Relevant Activities

Colombia has been actively exploring participation avenues under Article 6 of the Paris Agreement, especially in order to transfer mitigation obligations under Cooperative Approaches agreed in Article 6. In doing so, Colombia coordinates its position for Article 6 with the Independent Association of Latin America and the Caribbean (AILAC) group of countries, with whom Colombia negotiates in the UNFCCC[17]. Three noteworthy developments until the end of 2017 were the following:

- **Pacific Alliance regional carbon market.** Under the Pacific Alliance, Colombia has discussed the possibility of a regional voluntary carbon market and a common MRV framework towards it, with initial support from the PMR (Pizarro, 2017). Canada also announced to provide 1.6 million CAD to the Pacific Alliance countries to assess technological options for aligning their climate accounting procedures. Pacific Alliance is the trade alliance of Peru, Mexico, Chile, and Colombia (Pizarro, 2017).

- There have been a number of media reports on Article 6 pilot proposals with AILAC members. One proposal from Climate Focus outlines aa call option to realise ITMO transfers between Nordic Council countries and Peru in the solid waste sector (Chagas, 2018).

- Colombia's Universidad de los Andes collaborated with research institutions and think tanks from New Zealand, USA, and South Korea to develop scenarios to test a forest carbon trade that would involve transferring REDD carbon credits from Colombia to South Korea to help meet Paris Agreement goals (Carbon Pulse, 2018).

While various think tanks and research institutions discuss a range of collaborations, the Ministry of Environment stated that a governmental discussion on ITMO transfers will not happen until January 2019. Interviewees in Colombia during the September 2018 mission expect the new government to need until January 2019 to finalize its climate policy planning.

[17] An overview of the AILAC position on Article 6 of the Paris Agreement can be found on page 121

3 The Building Sector: Social Housing in the Overall Structure

Although emissions from residential housing - and particularly social housing - constitute a relatively small share of Colombian overall national emissions, reducing those emissions is an important mitigation opportunity for two reasons. First, the long lifetime of housing assets means that there is a particular danger of a lock-in to (higher) emission pathways. Second, emission reduction measures in the social housing sector can have important potential spill-over effects and synergies with other relevant government priorities in Colombia. For instance, increased efficiency would reduce the financial burden of energy subsidies to poorer households. Further, by switching from natural gas to renewable energy, future energy security can be increased and air pollution reduced.

This chapter explores the links between the building and energy sectors with a discussion of possible future emission trends associated with the building sector. It then goes to examine the structure of the social housing sector before looking at the potential for greenhouse gas mitigation in the sector and general barriers to mitigation action. The building sector in Colombia is highly dynamic and there are a number of public, private, national, and subnational efforts to improve energy efficiency and reduce emissions. We provide an overview of these initiatives with the aim to outline the most important next steps to reduce emissions in the social housing sector in particular, but also in the housing and building sectors in Colombia more generally.

The embedded emissions in the construction material of a residential building can be significant, but are generally comparatively small to the overall operational emissions of the structure (Rossi, Marique, Glaumann, & Reiter, 2012). The focus of our study is therefore on the operational emissions of social housing in Colombia. Further research should, however, investigate options to reduce the embedded emissions of materials and in the construction of the house. Further, the physical location of housing can have a large impact on the carbon footprint of its residents but other factors, such as urban and land use planning, and the availability of low emitting modes of transport, also play an important role. Therefore, this study does not go into emissions associated with the physical location of the buildings.

3.1 Structure of Colombian Building Sector and Barriers to Mitigation

Emissions associated with buildings can be categorised into **embodied emissions** and **operating emissions**. Embodied emissions mostly occur during the construction phase and depend on the type of material used, primary energy sources, and the efficiency of conversion processes in making the building materials and products. Some embodied emissions are also recurrent during a building's lifecycle i.e. in maintenance, replacement, and retrofits. Operating emissions occur due to energy use during a building's occupancy. These include emissions due to direct energy combustion (such as for heating); and indirect emissions from use of electricity for operating appliances, cooling, lighting etc. Overall, energy consumption is the main contributor to operational emissions in buildings.

Buildings have some direct (operational) emissions themselves that are caused by burning fuels on site. These are called scope 1 emissions. In 2014, direct emissions from residential, commercial, and public buildings accounted for 7.9% of total fuel combustion (OECD/IEA, 2014).

Buildings also cause indirect emissions from the consumption of energy in the form of electricity and sometimes heat where the fuel is burned elsewhere: scope 2 emissions. Moreover, buildings can affect other emissions, for instance when residents use a car to travel between the building and other places: the cars' emissions are considered scope 3 emissions.

This study focuses mainly on scope one and two emissions. However, for a holistic understanding of potential mitigation measures that can be achieved with interventions in the building sector, scope three emissions should also be taken into consideration.

Emissions from buildings are a function of the efficiency of buildings, the size and kinds of buildings, as well as the number of buildings, which is related to population patterns and growth. Population growth in Colombia has slowed drastically over the last 30 years and is now around 0.99% per year (Central Intelligence Agency, 2018). Various models do not predict a peak in population growth before 2050 (Cadelron 2016).

Considering the stable environment for economic growth, two factors will be important in minimising GHG emissions: promoting renewable energy to reduce the carbon intensity of energy and driving energy efficiency gains to reduce the energy intensity of GDP.

Colombia's energy consumption amounted to a total of 25 Million Tonnes of Oil Equivalent in 2015 (OECD/IEA, 2015). The residential sector consumed 4.79 Mtoe and the commerce and public service sectors (generally buildings) consumed 1.64 Mtoe – together almost 26% of total energy consumption. The primary energy sources for the residential sector are: electricity with 1.91Million Tonnes of Oil Equivalent or 40% of the total; biofuels and waste with 1.46 Mtoe or 30% of the total; and natural gas with 0.92 Million Tonnes of Oil Equivalent and 19% of the total. These sources are followed by smaller amounts of coal, and oil products (OECD/IEA, 2015).

Thus, the reduced use of natural gas and an improvement in the emissions profile of the electricity sector will be important to reduce emissions in the building sector. Gas is mostly used for water heating and cooking. In rural areas, people often make use of wood for cooking. Both water heating and cooking could be electrified, reducing GHG emissions.

3.1.1 Electricity Generation Mix

The current electricity mix in Colombia is relatively low carbon given the large hydroelectric resource in the country. In 2015, hydropower represented 65% of the total electricity production, gas produced 19%, and coal 12%. Wind power produced a statistically insignificant amount (IEA, 2016a). While hydropower is currently an important energy source in Colombia, changing el Niño patterns and associated droughts are likely to reduce future hydropower energy (Dennis, 2015).

Despite Colombia's active policy work on carbon pricing, current domestic carbon pricing policies are not relevant for emissions in the electricity sector as the carbon tax is not levied on coal and or gas for electricity production (Alarcon-Diaz et al., 2018). Discussions on the establishment of an Emissions Trading System are still preliminary with no concrete implementation or timing on the policy horizon. Looking at the future of the emissions from the electricity sector, renewable energy policies are currently the most relevant.

3.1.2 Renewable Energy Policy

The future of Colombia's low carbon electricity mix is somewhat unclear. Given the size of its economy Colombia lags significantly behind regional neighbours in renewable electricity investment (Flavin et al., 2014; WWF, 2014). Recent renewable energy auctions in Brazil and Mexico have proven to be exceedingly cost competitive (Dezem, 2018). In comparison, Greentech Media characterizes the Colombian solar PV market is only just emerging (Nagendran, 2017). The potential to expand hydroelectricity in the country is limited and changes in future rainfall patterns due to climate change may make hydroelectricity less dependable. Changing el Niño patterns lead to an uncertain future for hydro capacity (Mancero & Mancero Abogados, 2016).

However, there are signs that Colombia is catching up in the development of renewable energy. Colombia enjoys abundant wind, solar, and geothermal resources (Procolombia, 2015). The wind power potential in the region of la Guajira alone could satisfy energy demands of the entire country (Norton Rose Fulbright, 2017; Vergara, Deeb, Toba, Cramton, & Leino, 2010). Several large wind projects are already in the project pipeline in the north of the country (Mergermarket, 2017). Empresa de Energía de Pacífico (Epsa) announced in July 2018 that it would float bonds for non-hydro renewable energy projects, including a 185 megawatt tranche worth divided in four PV solar projects. These four projects are expected to produce 312 GW hours per year – enough for 171,000 houses (The Dialogue, 2018). The World Bank's International Finance Corporation and the Colombian National Development Bank (FDN) have committed to buying 145.5 million USD of Epsa's green bond issuance.

Further, the potential of using hydro as a complementary back-up capacity for solar and wind power has not been exploited. However, the best suited region of such hydro storage – Antioquia - has good connections to the national grid.

3.1.3 Renewable Energy and Energy Efficiency Law

In 2014, the Colombian government adopted a new Renewable Energy and Energy Efficiency Law (Law 1715/2014). This law promotes the development and use of non-conventional energy sources within the national energy system, through their integration into the electricity market. The law also establishes lines of action to achieve Colombia's commitments with regard to renewable energy, energy efficiency, and mitigation of GHG emissions (Government of Colombia, 2014). Two chapters are particularly relevant in the context of this project:

- Chapter II (Article 10) creates the **Fund for Non-Conventional Energy and Efficient Energy Management (Fenoge)** to finance renewable energy and energy efficiency programmes. Resources that nurture this fund can be provided by the national government, public or private entities as well as by multilateral and international organisms. The fund will be regulated by the Ministry of Energy. Resources from the fund can finance, partially or entirely, programmes and projects directed at the residential sector (strata 1, 2 and 3[18]), for the implementation of small-scale auto-generation installations as well as for energy efficiency improvements. Funding has so far been directed, inter alia, to renewable projects in poorer communities on the Caribbean coast.

- Chapter III creates different **financial incentives for renewable energy investments**, including income tax exemption, accelerated depreciation of assets, value-added-tax exemption and import duty exemption.

The first auctions for the procurement of renewable energy in Colombia were announced in November 2017 to take place in the first half of 2018 (MinMinas, 2017). Decree 0570 of 2018 changed the auction bidding criteria to some extent with to allow for non-renewable energy and includes criteria like the offer's ability to reduce emissions, diversify the energy matrix and enhance energy security which clearly favour renewable resources. The auction held in July 2018 purchased electricity on a long term basis. Costs will be covered by the end users with an

[18] Law 142 of 1994, which regulates the provision of public services, establishes a system of socio-economic stratification (Title VI, Chapter IV, Art. 101-104). Art. 102 defines six different stratums that classify residential buildings that receive public services: 1) low-low, 2) low, 3) medium-low, 4) medium, 5) medium-high, 6) high (República de Colombia, 1994).

increase in their energy tariffs. Further, Colombia is rapidly expanding its grid infrastructure to integrate large scale renewables such as wind into the national grid (MinMinas & UPME, 2018).

Despite these developments, Colombia is South America's largest coal producer and fifth largest coal exporter in the world in 2015 with over 6.7 trillion short tons of probably coal reserves (U.S Energy Information Administration (EIA), 2016). Colombia is also an important oil producer and exporter (ibid). The extractive industries driven economic growth and have large political influence (Briscoe, Villaveces-Izquierdo, Van Tilburg & Van Schaik, 2016). Although electricity demand has not grown significantly over the last decade (IEA 2017), both coal and gas have increased their share in the Colombian electricity mix since 2011 (IEA 2017). There are currently four new coal fired power plants in various stages of the planning and construction process: the Guaduas power station in Cundinamarca; the Gecelca-3 power station Unit 2 in Córdoba; the Termopaipa power station Unit 5 in Boyacá; and units 3 and 4 at Termotasajero power station in Norte de Santander (WRI, 2018). If these plants are built, it is likely that the emissions intensity of the economy, and specifically of the electricity sector, will increase.

3.1.4 Population Distribution

In 2016, 76.7% of the Colombian population lived in cities (World Bank 2018). Bogota is Colombia's capital and the largest city with a population of 9.765 million; Medellin is the second largest with a population of 3.911 million; followed by Cali (2.646 million); Barranquilla (1.991 million); Bucaramanga (1.215 million); and Cartagena (1.092 million) (Central Intelligence Agency, 2017). The climatic zone of these cities has a large impact on the energy needs of their populations. Bogota has a warm temperate climate with average high temperatures of 19-20°C and average low temperatures of 6-9°C, so there is limited need for heating and cooling. Barranquilla has the highest ambient temperatures of the large urban areas in Colombia with highs of 31-33°C and lows of 24-25°C (US National Oceanic and Atmospheric Administration 2018). As a result, Barranquilla has a high electricity demand for air conditioning (ibid).

The Colombian constitution of 1991 gives all Colombians the fundamental basic right to the provision of public services of water, sewerage, and electricity regardless of property rights (Aristizabal & Ortiz, 2001). Law 388 of 1997 sets guidelines for urban planning and provides local governments management tools to manage land use planning.

3.1.5 Socio-Economic Factors

The statistics office estimates that there were 14.4 million housing units in 2016 for a population of 48.3 million inhabitants (DANE, 2016b). While almost all houses were connected to the electricity grid, only two thirds had access to the public natural gas network.

Table 1: Access to public services

	Housing Units (thousands)	Occupation (persons per unit)	Electricity Supply	Natural Gas Network
Urban	11,410	3.3	99.7%	78.8%
Rural	3,037	3.6	95%	11.9%
Total	**14,447**	**3.3**	**98.7%**	**64.7%**

Source ENCV

Table 2 shows house ownership and the economic situation of the occupants. Just under half of the housing units are owned by their occupants, most of whom have paid back any credit in full. Thirty-seven per cent of all Colombians live in a rented unit, 14% live in their residence free of

charge, and about 3% occupy their dwellings without the owner's permission. Homeownership rates are much higher in rural than in urban settings, but most new construction takes place in cities.

Table 2: Housing ownership and economic situation

	Ownership of the Housing Unit					Funds for Basic Needs		
	Own (fully paid)	Own (paying back loan)	Rent-ing	Usage free of Charge	Squat-ting	Insuffi-cient	Just Suffi-cient	More than neces-sary
Urban	40.1%	4.7%	43.5%	9.6%	2.1%	27%	59.4%	13.4%
Rural	52.6%	1.7%	11.9%	28.5%	5.4%	50.8%	46.4%	2.7%
Total	**42.8%**	**4%**	**36.8%**	**13.6%**	**2.8%**	**32.1%**	**56.7%**	**11.1%**

Source: ENCV

In the provision of public services, Colombia divides the population up into 6 socio economic categories or strata. Strata are based on the quality of the housing sector and the surroundings according to a methodology developed by DANE. Each area is classified into one of the following six groups[19]:

- Very low (Strata 1);
- Low (Strata 2);
- Lower middle (Strata 3);
- Middle (Strata 4);
- Higher middle (Strata 5);
- High (Strata 6).

In the first quarter of 2017, 40% of all area under construction belonged to the lower levels 1-3 which receive subsidised public services. Twenty-eight per cent belong to the group 4 and 32% to the two highest groups 5 and 6 (DANE, 2017a).

Table 3: Number of Electricity Subscribers by Strata

Strata/Category of Subscribers	Number of subscribers (in 2015)
Strata 1	3,241,856
Strata 2	4,583,456
Strata 3	2,679,451
Strata 4	879,451
Strata 5	350,799
Strata 6	207,219

[19] As an example, a map of Bogota divided into strata can be found here: The following link leads to the internet: http://www.sdp.gov.co/portal/page/portal/PortalSDP/InformacionTomaDecisiones/Estratificacion_Socioeconomica/Mapas

Strata/Category of Subscribers	Number of subscribers (in 2015)
Total Residential	**11,942,302**

Source: (UPME, 2016)

3.1.5.1 Electricity Subsidies

Electricity subsidies apply only in the range of a "basic consumption" set at 139 kWh/month in areas at an altitude above 1,000 meters above sea level and at 173krWh/month for areas 1,000 meters below sea level. Until recently, strata 1 users received a subsidy of up to 60%, Strata 2 up to 50%, and Strata 3 up to 15% of the unitary tariff. Strata 5, 6 pay a contribution of 20% above the Strata 4 rate. Until 2011, commercial energy consumers also contributed to the strata system through higher rates but they were exempted starting in 2012, leaving a larger deficit, which the Colombian government has to cover. This deficit amounted to approximately 93 EUR per household in strata 1-3 in 2015, with strata 1 households receiving more and strata 3 households receiving less. Total subsidies received by strata 1-3 amounted to 953.72 million EUR in 2015 (UPME, 2016). In January 2018, the Ministry for Energy and Mining announced that the subsidies for strata 1 would be reduced to 50% of basic consumption and subsidies for strata 2 would be reduced to 40% of basic consumption starting in March 2018 (Betín, 2018).

The lower three strata (those who receive subsidies) account for 88% of all electricity subscribers; only 8% of subscribers pay the general rate, and 5% of subscribers pay a premium on their electricity consumption in order to contribute to a portion of the subsidies for poorer strata. This cross subsidisation between strata is not sufficient to pay for the subsidies going to the lowest strata and leaves a large deficit that must be covered through money from the central government. In 2015, strata subsidies cost the government between 2.2 and 2.6 trillion COP, higher rates paid by strata 5 and 6 only covered 976.014 million COP in 2015 (Muñoz, 2016; UPME, 2016).

The deficit grew significantly after commercial and industrial electricity consumers were exempted from paying into the strata cross subsidy in 2011 (Muñoz, 2016). Strata subsidies amounted to 95% of the total budget of the Ministry for Energy and Mining (Bansard, Pattberg, & Widerberg, 2016) prompting a reduction of the subsidies for strata 1 and 2 (see above).

The basic rate for non-subsidised electricity in Colombia varies both geographically and through time. Table 4 shows electricity prices in selected cities in April 2018.

Table 4: Strata 4 Electricity Prices in Selected Cities

City	Electricity Provider	Energy tariff for residential customer in Strata 4 per KwH
Bogotá	Condesa	494 COP (approx. 0.14 EUR)
Medellín	EPM	485.73
Barranquilla	Electricaribe	418
Cali	Emcali	514

Source: webpages of each company as of June 2018 (The following link leads to the internet: www.codensa.com.co , The following link leads to the internet: www.epm.com.co , The following link leads to the internet: www.electricaribe.co, www.emcali.com.co)

3.1.5.2 Natural Gas Prices

Natural gas has a fix cost and a variable cost. Subsidies apply only in the range of a "basic consumption" that was set to be 20 m^3 per month. In Strata 1 users have a subsidy up to 60%, and

strata 2 up to 50%. Strata 3 and 4 do not have subsidies and do not pay contributions. Users in strata 5 and 6 pay a 20% of contribution, and commercial users a contribution of 8,9%.

Table 5 shows natural gas prices for Bogotá (Gas Natural Fenosa), for Medellín (EPM), Barranquilla (Gases del Caribe) and Cali (Gases de Occidente) in April 2018.

Table 5: Strata 4 Natural gas prices in selected cities

City	Gas Provider	Natural gas variable tariff for residential user	Natural gas fix tariff for residential customer per month per m^3
Bogotá	Gas Natural Fenosa	1607,91	3037 COP (approx. 0.86 EUR)
Medellín	EPM	1267.83	3012.69
Barranquilla	Gases del Caribe	1425	3742
Cali	Gases de Occidente	1678.72	2359.29

Source: webpages of each company (The following link leads to the internet: www.gasnaturalfenosa.com.co , www.epm.com.co , The following link leads to the internet: www.gascaribe.com , The following link leads to the internet: www.gdo.com.co)

Table 6: Natural gas residential subscribers

Category of subscribers	2013	2014	2015	2016
Strata 1 to 3	5.989.704	6.493.331	6.844.370	7.232.891
Strata 4 to 5	1.042.540	1.107.474	1.165.337	1.235.812
Total	7.032.244	7.600.805	8.009.707	8.468.703

Source: Promigas. Informe del Sector Gas Natural 2017. Cifras 2016. XVIII Edición.

3.1.6 Sectoral Structure

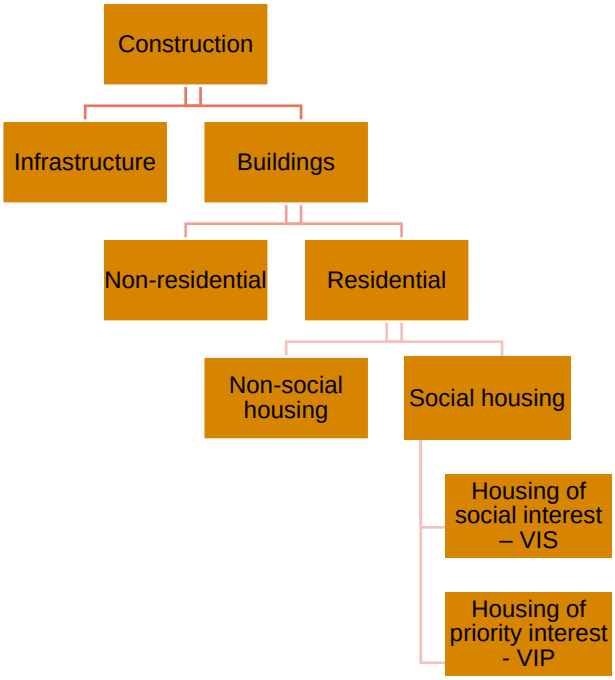
The social housing sector is an interesting sector for both the Colombian and German governments. A subsector of the larger building sector, Colombia considers it part of the wider **construction sector**. The construction sector is an important driver of Colombia's economic development, promoting employment and significantly contributing to the country's GDP. It is composed of the building and infrastructure sectors as two large subsectors. Between the third quarter of 2016 and the third quarter of 2017, the construction sector grew by 2.0%, with a decrease of 1.3% in the subsector of buildings and an increase of 4.8% in the subsector of public infrastructure. In comparison, GDP grew by 1.3% in the same time period (DANE 2017, 2017).

The building sector can be divided into non-residential and residential subsectors. While the non-residential segment includes buildings with a variety of different functions[20], the residential segment can be divided into social housing and non-social housing. In Colombia, social housing includes 'Housing of Social Interest' (Vivienda de Interés Social – **VIS**) and 'Housing of Priority Interest' (Vivienda de Interés Prioritario – **VIP**). Non-social housing is all housing that does not

[20] According to DANE, the non-residential segment includes: industrial buildings, offices, wineries, commercial buildings, hotels, educational buildings, hospitals, public administration, religious buildings, social-recreational buildings and "others", which includes parking lots and stables (DANE, 2016a).

fall under the definition of VIS or VIP. See Figure 3 for a schematic overview of the sector and subsectors. The focus sectors for the pilot are marked in red.

Figure 3: Construction Sector and sub-sectors including social housing



Source: DANE 2016a

According to Law 388/1997[21], the Colombian Government has to define the type of and price social housing (VIS and VIP) in every National Development Plan (Plan Nacional de Desarrollo – PND) (DANE, 2014). Under the current PND (2014-2018), **VIS** is defined as a housing unit with a maximum total value of up to 135 minimum monthly salaries (the equivalent of 33,345 USD). **VIP** is a subcategory of VIS and defined as a housing unit with a maximum total value of up to 70 minimum monthly salaries (the equivalent of 17,290 USD)[22] (Departamento Nacional de Planeación, 2014). The size of housing units in the VIS and VIP categories is regulated through Decree 2060/2004 that establishes that single-family houses have a minimum lot size of 35 m^2, two-family houses a minimum lot size of 70 m^2, and multi-family houses a minimum lot size of 120 m^2 (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2004). The vast majority of social housing units are in four to five story buildings with four units per floor. These are sold, in a raw unpainted state, without any floor finishing, light fixtures or appliances.

In order to secure financing for the purchase of a new house, the following conditions must be met:

1. The buyer must be able to pay for a minimum of 30% of the value of the house up front, and a financial provide credit financing for up to 70% of the value of the house. A common modality is to pay the 30% during the construction phase through a trust-fund.

[21] Available at: The following link leads to the internet: http://www.catastrolatino.org/documentos/foros_tematicos_IGAC/foro%20I/legislacion/adjuntos%20colombia/ley388de1997[1].pdf (in Spanish).

[22] In 2017, the minimum monthly salary amounts to 737,717 COP which is equivalent to 247 USD (calculated at the conversion rate of January 2017) (Portafolio, 2017).

2. The financial entity can offer two types of credits: in pesos and in UVR (constant value units). The UVR is a unit that annually is adjusted for inflation. The credits are up to 30 years (usually they are 10 to 15 years), and can have the following modalities:
    a. Constant monthly payment in UVR or pesos
    b. Constant capital (principal) amortisation
    c. Annual increment but equal monthly payment within each year.
    d. Decreasing monthly payment
3. There cannot be capitalisation of interests. Every payment should pay something of the principal.
4. The buyer can make additional payments without penalisation and can choose to reduce time or amount of the monthly payment.
5. The interest rate (in pesos or UVR) should be fixed over all the period of the credit.

Table 7: Current interest rates for housing financing

	For VIS housing	For non VIS housing
Average of 19 local financial institutions	12.3%	11.28%
Highest rate found	14.11%	14.9%
Lowest Rate Found	8.99	9.73%

Source: Superintendencia Financiera de Colombia. Rates in April 13, 2018.

3.1.7 Planning

Currently, there are 14.5 million houses in Colombia. There were 800,000 further housing units are planned including both social and non-social housing between 2014 and 2018.

Looking towards 2030, the Colombian government expects population growth rates of 1% a year. However, growth is not evenly distributed and larger in urban than in rural areas. Just over half of overall population growth, and associated therewith, growth in the housing sector is expected to take place in four growth hotspots including Bogota, Medellín, Cali, and Barranquilla.

The International Finance Corporation expects the total floor space of buildings in Colombia to expand at a compounded annual rate of 0.93%, but most growth will come from the commercial sector. The residential sector represents 93% of total building floor space, but is expected to have slower annual growth of 0.76%, with multi-unit residential units outpacing single-family detached homes (IFC, 2017b). Construction licenses declined in 2016, which could signal a longer decline (IMF, 2017).

The Colombian government is making a large effort to expand social housing in order to improve the living standards of the urban poor and to cope with continued urbanisation. Stakeholders point to a consistent qualitative and quantitative housing deficit. DANE collects and provides data on added square meters for VIS, VIP, and non-VIS on a monthly basis. In 2016 a total area of approximately 25.0 million m^2 was licensed for the construction of buildings, of which 18.6 million m^2 (81%) correspond to housing and 6.5 million m^2 (19%) to the non-residential segment. From the area licensed for housing, 13.9 million m^2 (75%) were approved for non-VIS and 4.7 million m^2 (25%) for VIS and VIP. This corresponds to a total of 194 thousand housing units in the same time period. For non-VIS, 118.9 thousand units were approved, while for VIS and VIP, 75.0 thousand units were licensed. In the social housing sector 93% of all new units were

apartments in multi-family homes; in the general housing sector this figure is only 68% (DANE, 2017b).

A total of 62.4 thousand purchases of new social housing units and 9.5 thousand used units in 2016 were financed through private and public banks. On average, the credit value was around USD 15.000 for new and existing houses. About half of the credits for new social housing were subsidised.[23] The credit on average covers approximately half of the total costs of a new social house.

Construction rates both for the social and for the general housing sector vary considerably from year to year in Colombia, a reflection of economic cycles, as well as shifting government priorities and policies.

The cities that are expected to grow the most in absolute population between 2015 and 2030 are: Bogota by 1,367,497 inhabitants, Medellín by 408,083 inhabitants, Cali by 343,717 inhabitants, Barranquilla by 185,916 inhabitants, Cartagena by 150,571 inhabitants, Villavicencio by 130,902 inhabitants, and Soacha by 105,762 in habitants. If the proportion of VIS/VIP housing in these cities remains constant as they grow, up to 44 million square meters of VIS/VIP housing may be needed by 2030.[24]

3.1.8 Powers and Roles of Sub-national Governments

There are two primary control measures for the enforcement of building codes. One set is important with regard to construction licensing, compliance with local planning documents such as the territorial ordering plan (POT) and the other focusses on seismic stability requirements. Construction licenses are granted by "*curadores*", to whom larger municipalities (generally over 100,000 inhabitants) delegate the task or reviewing construction applications, or directly by the planning offices of smaller municipalities. *Curadores* are responsible to oversee construction projects and to ensure compliance with urban norms and the POT. For projects over 2,000 square meters, independent reviewers and supervisors are hired to review the structural designs of the project and to certify compliance with technical requirements. Supervisors are responsible for overseeing the construction phase of projects and for making sure that projects are built according to design. The supervision covers technical specifications, structural, and geotechnical requirements. At the end of the construction, if everything is built according to code, the curador issues an "occupation certificate". *Curadores* have a role in checking compliance with the main building energy efficiency instrument of Colombia: resolution 549 (explained in section 3.3.1.3). Approval timelines could differ between cities and in practice. As an example, in the city of Bogota, about 90 working days are taken to approve the building license. Thereafter, construction is to be finished within two years. If unfinished, the project developer needs to re-apply.

As a result of the high profile building collapse in Medellin in 2013 (Cañas Carmago, 2014), regulations and the system for the oversight of *Curadores* were reformed. A new regulation for inspection in the sector was established by Safe Housing Law 1796 of 2016 and the Decree 1203 of 2017. Resolution 0463 of 13 July 2017 created a standardised national application form for construction licences for the cities of Bogota, Medellin, Barranquilla, and Cali. However, checks on energy efficiency and appliance use were intentionally excluded considering capacity limitations of the *Curadores.* Hence, in terms of institutional arrangements, there is currently a gap in mandate to carry out checks for building energy use and energy efficiency, as *Curadores* do not

[23] Own calculation based on data from FINANCIACIÓN DE VIVIENDA – FIVI 2016: The following link leads to the internet: http://www.dane.gov.co/index.php/estadisticas-por-tema/construccion/financiacion-de-vivienda/financiacion-de-vivienda

[24] Authors' calculation based on data from DANE and MinVivienda.

review electricity and water usage while the electricity company's (utilities) mandate ends at checking functioning of electric meters.

3.2 Barriers to Mitigation in the Building Sector

To a large extent the inherent barriers that the IPCC identified for the world at large, also apply in the Colombian case, including for social housing. These include the large number of stakeholders involved; fragmented market and institutional structures; cultural aspects; challenges of enforcing existing building guidelines; the sector's high heterogeneity with vast variances in building practices through time; cognitive and behavioural patterns, in different geographic regions, and between construction firms; a large number of measures would lead to comparably small emissions savings; split incentives between building owners and renters (principal agent problems); transaction costs; long investment payback periods; limited capital / access to financing'; risk aversion; distorted tax regimes and energy consumption subsidies, patents and barriers to technology transfer; a lack of information and awareness hinder investments to be made; and the monitoring and verification of which pose challenges as well as high transaction costs (Lucon et al., 2014).

3.2.1 Fragmented Market and Institutional Structures

General sector characteristics such as the diverse and dispersed nature of the housing units (as indirect emissions sources) represent a challenge to implement mitigation measures in the sector compared to large point indirect or direct emission sources. The challenge is also related to the large number of potential measures that could contribute to increased efficiency from building design, appliance efficiency, and on-site renewables such as solar hot water heating or solar panels. Generally, there is a lack of sectoral data. Accurate and granular information on energy use is not public but could presumably be gained from utility companies.

On the local level, a large number of companies and other stakeholders are active in the building sector. Many construction companies are small and family owned, with varied interactions with different local authorities that have their own regulatory powers. A lack of capacity as well as expertise for monitoring and evaluation, and ensuring compliance with building codes of so many construction companies also constitutes a major barrier.

As mentioned in section 2.2.4, the overall 20% GHG reduction target from the national projected BAU scenario is subdivided into 20% reductions among several ministries, including the Ministry of Housing and the Ministry of Energy. The reduction target has created an accounting challenge, because different ministries take measures reducing emissions in the same sector. The Ministry of Housing expects to achieve the 20% reduction primarily through Resolution 0549 and the associated Sustainable Construction Guide (see Section 3.3.1.3). The Ministry of Energy is implementing a number of measures including in the area of energy efficiency of household appliances that may overlap with the measures of the Ministry of Housing. This has led to potential coordination challenges that constitute a barrier to policy implementation in the sector. The Ministry of Environment, which has a general function in terms of climate policy implementation is involved in the baseline setting. However, the Ministry of Housing has already expressed scepticism about the methodology to determine baselines the Ministry of Environment uses.

3.2.2 Capacity Deficits

According to various stakeholders, a lack of resources on the national and subnational levels to monitor, verify, and enforce compliance with energy efficiency standards forms a significant barrier to the effective implementation of these standards. This leads to data inconsistencies and a lack of data that constitute a further major barrier for setting baselines and data collection was

particularly problematic in cities. Informal buildings with no construction licence account for almost 50% of all construction in Colombia (H. Vargas et al., 2013), for these buildings no data is collected at all and they do not apply for construction licences. For buildings to qualify as social housing, however, local authorities must issue a construction licence. There is limited knowledge of lower emission building in the construction sector, and contractors are generally not prepared to implement energy efficiency measures (ibid).

While the Ministry of Housing is responsible for setting and achieving national targets, enforcement almost completely falls on local governments. This leads to unclear and uneven outcomes. In terms of national energy efficiency standards, as described in the Sustainable Building Guide, compliance largely depends on "auto-declaration" where a real estate developer or housing construction company attests to adhere to norms at the time of getting construction license. Awareness and processes for implementation to check for the measures in Resolution 549 varies on the local level, but because of time lags, buildings built in 2020 may still be based on construction licences issued before the auto-declaration was incorporated into the construction licence form.

According to interviewees, in some cases, corruption and a lack of expertise may play a role in a construction company failing to adhere to building and energy efficiency norms. The POTs and other building codes, such as for seismic stability, are supposed to be overseen by *Curadores*, but a lack of strict oversight has been a problem. Two recent collapses large residential buildings - "Space" in Medellin and of "Portal Blas de Lezo II" near Cartagena - illustrate the problems in the sector. There are currently 238 disciplinary proceedings against curators for failing in their control and surveillance duties. *Curadores* are normally directly appointed by local mayors, leading in many cases to appointments without the qualifications to carry out their oversight mandate (M. Vargas, 2018). These proceedings prompted a reform of the qualification and appointment of the system of *Curadores*, but the reform needs time to take full effect (Cañas Carmago, 2014).

Further, there is a general lack of well-trained building inspectors and verifiers with the necessary qualifications to assess the energy efficiency of buildings, an issue corroborated by workshop participants. Interview partners noted that only six inspectors in Colombia were certified to perform inspections for standards such as LEED. This compares to over 200 for Brazil and many more in other Latin American markets.

3.2.3 Limited Capital / Access to Financing

Generally, although energy efficiency investments may lead to overall savings over time, many mitigation technologies are associated with frontloaded costs, which lower income groups are least likely to be able to afford.

A larger barrier than the costs themselves, however, is the perception of costs. Although the costs for many measures are actually relatively low compared to the overall cost of construction, construction companies perceive them to be high. Awareness efforts may play a large role in overcoming this issue.

With regard to Energy Service Companies (ESCOs), a significant barrier to an energy efficiency market is the limited knowledge and experience of local financial institutions with the sector (IDB, 2015). As a result, these institutions generally are unwilling to finance ESCOs based on long term future capital flows. Interviewees also cited unfamiliarity of companies with the ESCO model, and the lack of the ability to enforce longer term contracts in some cases.

3.2.4 The Principal Agent Problem and (Perceived) "Circle of Blame":

The principal agent split incentive barrier, where the actor with the ability to carry out structural improvements (e.g. landlord) is not the actor that would benefit from the investment (e.g. renter) is not directly relevant in the Colombian social housing sector. Inhabitants of social housing buildings often buy their apartment, rather than renting it from a landlord. Some interviewees mentioned that a similar principle agent problem existed in that construction companies do not have an interest in incorporating energy efficient features because they do not profit from the savings. Camacol, the Colombian construction industry association, for instance describes a "circle of blame"[25] where (Jaimez, 2018):

- Potential homeowners say that they are interested in efficient housing measures such as for lighting and water savings, but such options are not on offer;
- Construction companies and developers say that they could construct efficient buildings, but that there are no incentives to do so; and
- Finance institutions say that they could finance efficient building, but there is no demand for such buildings.

The Colombia Green Building Council (CCCS) suggested that better communication could help overcome this barrier and that the interest of potential home owners in energy efficient housing meant that such housing is sold faster than other housing options. This should provide an incentive for the construction of more energy efficient housing. Moreover, at the very minimum energy efficient features allow for "green marketing" which could provide an incentive for construction companies and housing developers to move towards more energy efficient housing in some markets[26]. The CCCS cited a number of social housing projects where energy efficiency features were the primary selling point for buyers and that interest of buyers was the main consideration for the construction company involved in the building.

3.2.5 Past Efforts to Promote Uptake of Natural Gas a Fuel

Prior to the 1990s, electricity and oil played a larger role in household energy use. Expecting to discover additional oil and gas resources, the Colombian government made efforts to encourage increased use of natural gas (DNP, 1991, 1993). The increased dependency on gas poses problems for emission mitigation in the sector compared to the period in the 1990s when electricity played a bigger role in cooking and water heating.

3.2.6 Specific Barriers in the Social Housing Segment

In addition to the mitigation barriers prevalent in the building sector, specific barriers hinder mitigation in the social housing segment. These barriers relate to price caps for VIS-VIP housing and energy subsidies

3.2.6.1 Price Caps for VIS-VIP Housing

Price caps for VIS and VIP housing represent at least a perceived barrier because building more energy efficient housing comes at additional costs for building developers. Because the cost of VIS and VIP housing is capped by the government, builders are not able to pass increased cost onto homebuyers. However, several stakeholders, including CCCS and Camacol, found a

[25] Circulo de Culpa

[26] Interview with the Colombia Green Building Council (CCCS). 14 March 2018. Bogotá, Colombia

significant number of energy efficiency features could be implemented at little to no cost. This suggests that the perception of higher costs and current practice are higher barriers than the costs themselves.

3.2.6.2 Energy Subsidies

Despite recent reforms, energy subsidies for lower strata (section 3.2.6.2) are still considerable. These subsidies reduce the financial incentive to invest in energy efficiency or to extend pay-back periods for efficiency investments. Nevertheless, cost of subsidised power can have some impact on occupant behaviour. For instance, the interest in solar PV installation in social housing came from the Antioquia region, where power charges are among the highest in the country.

Another important barrier to mitigation are the disconnected objectives of short-term social housing provision and long-term sustainability. Social housing policies are currently directed to cater the most urgent housing needs of the lower income groups at the lowest possible upfront cost. Yet, these policies do not take the overall energy costs in the short- or medium-term for either the government or the residents into consideration, let alone long-term sustainability and comfort in social housing construction. Making the compliance with the building energy efficiency measures of resolution 549 mandators for most buildings, but voluntary for social housing is an indicator of these delinked agendas.

Lastly, a challenge in implementing energy efficiency measures in low-income housing is that the housing dwellers in this segment are likely using less energy than they would if they had an average standard of living. If their incomes rise, they are likely to consume substantially more energy. Voluntary sustainability and energy efficiency certification programmes such as EDGE and BEA take this into consideration when estimating future energy requirements for thermal comfort in buildings separately. In the EDGE programme, for instance, buildings with no plan for space heating and cooling systems, a scenario when such energy requirement would exist is additionally presented (called 'virtual energy') and is used in calculation of energy consumption improvements. BEA includes additional voluntary mitigation measures that also enhance 'thermal comfort in social housing[27].

3.3 Mitigation Activities in the Housing Sector

Many actors are promoting energy efficiency in the (social) housing sector. Their efforts include designing long-term emission reduction strategies that set broad sectoral priorities. Examples of these strategies include the CONPES strategy for sustainable buildings and Sectoral Action Plan for mitigation in the housing sector (Planes de Acción Sectorial – PAS) of 2014. While the housing PAS is expected to play a high-level vision setting role on GHG growth in the housing sector and to set priorities, the four-year development plans and more targeted sectoral policies provide short-term directions.

The Ministry of Housing's main instrument to promote energy efficiency in the building sector is Resolution 549 that was issued in 2015. The Ministry for Mines and Energy complements this work through several efforts for energy efficiency promotion ranging from appliance labelling, to incandescent lightbulb phase outs, to energy subsidy reforms. Further, there are a number of Ministry of Energy measures to promote distributed generation of renewable electricity.

In parallel, the private sector and civil society have been actively popularising building energy efficiency. The specific role of main banks such as Bancolombia, industry associations such as CAMACOL, non-profits such as CCCS is particularly noteworthy. Bigger cities such as Bogota and

[27] Based on personal communication and presentation during project workshop.

Medellin are actively exploring measures in the building sector through regulatory. International donor agencies are facilitating the work of non-state actors. In the following, we provide a more detailed overview of the various initiatives promoting energy efficiency in the building sector.

3.3.1 National Mitigation Plans and Policies in the Colombian Housing Sector

3.3.1.1 Housing Sectoral Action Plan of Colombia's Low Carbon Development Strategy

Colombia has already begun to develop a low-carbon roadmap for the building sector. A Sectoral Action Plan (PAS) for mitigation in the housing sector was developed as part of Colombia's Low Carbon Development Strategy in 2014. The plan includes projections for the growth of GHG emissions as well as emission reduction potentials in the housing sector till 2040. Emissions in the housing sector are estimated to increase at an annual growth rate of 3.3%, reaching 17 million tCO_2e per year in 2040, and 339 million tCO_2e accumulated over 2010-2040. PAS identifies mitigation focus areas within the housing sector as well as options for financing and cooperation for low-carbon development. The emission reduction potential of the sector is estimated at 38 million tCO_2e accumulated through 2040 or 11.2% reduction than the estimated future emissions (Ministerio de Vivienda Ciudad y Territorio 2014b). To realise this potential, the ministry identifies two generic priority areas: a) **energy efficiency of appliances** used in the residential sector (electrical appliances, air conditioners and natural gas stoves); and b) **infrastructure and construction related improvements** (promoting low-carbon inputs in construction material, develop new housing projects with sustainability elements in the shell and promote thermal districts to optimise building refrigeration and the use of ozone depleting substances). However, no concrete targets to realise the estimated reduction potential and plans to realise mitigation in priority areas are identified (Ministerio de Vivienda Ciudad y Territorio, 2014).

3.3.1.2 CONPES Process

The Colombian government approved a CONPES strategy for sustainable buildings in March 2018. CONPES documents are policy documents outlining governmental goals in a particular field. They reflect high level "consensus" among different Ministries and their implementation is supervised by DNP. However, after a new government is elected, it can change or decide to not implement the CONPES documents.

The CONPES strategy for sustainable buildings sets goals for all new buildings to comply with sustainability criteria by 2030. According with the CONPES document, the Ministry of Housing, Cities and Territories (MinVivienda) will oversee defining the sustainability criteria, with the support of the Environment Ministry and UPME. These criteria should be issued in a regulation (Decree or Resolution) of the Ministry of Housing. The timetable established in the CONPES provides that thecriteria will be formulated between 2019-2020. the Ministry of Housing will define the implementation period.

The CONPES is not a regulation itself and therefore does not substitute or modify the sustainable construction guide. However, the Housing Ministry's regulation to implement the CONPES strategy that will include the "sustainability criteria" will modify the existing sustainable construction guide (Resolution 0549 of 2015). The CONPES identified some issues that are needed to improve the guide: cover all types of building (including VIS as well as non-residential), differentiated by climate zones, and differentiated by urban and rural houses. Annex E of the CONPES has a table as a general guideline for establishing the sustainability criteria of buildings.

CONPES documents represent a consensus among ministers, but their continuation and implementation depend on the next government. However, long term sustainability targets for

residential housing are not controversial, so the next government is likely to continue to elaborate and implement them.

Although a draft decree or resolution should be published for public comments, the process to involve stakeholders in implementing the CONPES is not regulated. Usually the process includes organising workshops to receive inputs with the main private associations, municipalities, etc. As per the timetable, this process will begin next year with the new government.

3.3.1.3 Resolution 0549 and the Sustainable Construction Guide

The Colombian government issued resolution 0549/2015 under the Decree 1285 of 2015, which included a Sustainable Construction Guide. The guide was developed by the Ministry of Housing, in close consultation with the World Bank's International Finance Corporation (IFC) and CAMACOL, the Colombian construction trade association. The guide establishes targets for energy and water efficiency in seven different building types: hotels, hospitals, offices, commercial centres, schools, housing (non-VIS), and social housing (VIS/VIP); and in four different climatic zones: cold, temperate, hot and dry, and hot and humid. It also provides a list of measures (approximately 80) that can be applied to achieve the targets. Although national targets and measures exist in the social housing sector (VIS/VIP), they are not mandatory. Local governments, however, can mandate various measures.

The Sustainable Construction Guide includes active measures (addressing equipment) and passive measures (addressing construction and design) for energy efficiency, as well as general measures for water efficiency. The measures are rated for each building type and climatic zone into: highly recommendable, moderately recommendable, and not recommendable. If all relevant highly recommendable measures were applied in a certain building type, this would be sufficient to achieve the respective energy and water efficiency targets for this building type. Resolution 549 and the Sustainable Construction Guide took effect on 10 July 2016, but because an implementation plan was missing, the Sustainable Construction Guide has had little influence thus far.

Construction companies are required to make a "compliance declaration" when filling out the standardized national building permit application form created by Resolution 0463 (See section 3.2.4 on 1.1.1 Powers and roles of sub-national governments). Architect and construction companies must sign this declaration, affirming that the building complies with the measures required in the Resolution 549. If companies falsifying the declaration, municipalities can impose sanctions according to resolution 1052 of 1998. *Curadores*, on behalf of the municipality, are responsible for the inspection of buildings. Since the process of obtaining a construction licence can take up to one year, and new construction projects generally last for up to three years, it will take until 2020 or 2021 for the first verification that new buildings are complying with the new measures, including those provided by the Sustainable Construction Guide.

Compliance with the targets set by Resolution 0549 is verified through auto-declaration (in theory, the government's proposed measures outline the exact percentage of energy and water savings possible in case of compliance). But in practice enforcement and monitoring are lacking so it is unclear to what extent targets will be met. The Ministry of Housing is currently working on a monitoring and verification scheme to supervise compliance. A specific sanction scheme does not yet exist.

For commercial buildings, hospitals and educational facilities Resolution 0549 sets minimum thresholds below which the application of the standards is voluntary. The housing sector is divided between general housing and the two different social housing types (VIS, VIP). For general housing, there is no minimum threshold, i.e. all new buildings need to comply, whereas the

application of the standards for social housing is entirely voluntary. Table 8 shows the minimum energy performance standards (MEPS) by climate zone and building type from 2017 onwards. These standards will be reviewed every two years and updated if the general conditions and technological development allow for it.

Table 8: Minimum energy efficiency improvement requirements per building type and climate zone (Resolution 0549).

			Climate Zone			
	Building Type	**Minimum Threshold**	**Cold**	**Moderate**	**Hot and Dry**	**Hot and Humid**
Mandatory	Hotels	50 rooms	20%	35%	25%	45%
	Hospitals	5,000 sqm	35%	25%	35%	30%
	Office Buildings	1,500 sqm	30%	30%	40%	30%
	Shopping Centres	6,000 sqm	25%	40%	35%	30%
	Educational Facilities	1,500 students	45%	40%	40%	35%
	General Housing	No threshold	25%	25%	25%	45%
Voluntary	Social Housing (VIS)	No threshold	20%	15%	20%	20%
	Social Housing (VIP)	No threshold	15%	15%	20%	15%

Source: Resolution 0549

The MEPS are design standards for the entire building (whole house approach), limiting the energy demand per square meter and year. The standards apply to the design of the building under normal conditions: real energy and water consumption can vary widely depending on occupation and usage but is not monitored. Developers need to demonstrate that their buildings are planned in a way to reduce energy and water consumption through passive and/or active measures. Passive measures are measures which reduce consumption through the physical characteristics of the building (e.g. insulation, orientation, type, and size of windows). Active measures are mechanical or electrical systems such as efficient illumination, active ventilation with heat recovery, or solar water heaters. A list of possible measures in the different climate zones, their reduction potential, and costs is included in the Sustainable Construction Guide[28] which is annexed to Resolution 549 (see also Table 9). Highly recommendable measures lead to a cost increase of less than 1% compared to a situation in which no measures are taken have a return on investment of less than three years and reduce energy consumption by at least 5%. Moderately recommendable measures increase building costs by up to 5% compared to no measures, have a return on investment of no more than five years, and reduce energy consumption by at least 3%. Implementing all recommended measures would ensure that the new houses meet the MEPS. However, developers may use other measures as they see fit.

[28] Ministerio de Vivienda, Ciudad y Territorio, Anexo No. 1, Guía de construcción sostenible para el ahorro de agua y energía en edificaciones, 2015

Table 9: Energy consumption reduction potential by climate zone and housing type quantified measures included in the Sustainable Construction Guide.

Measure	Social Housing (VIS/VIP)				General Housing			
	Cold	Moderate	Hot and Dry	Hot and Humid	Cold	Moderate	Hot and Dry	Hot and Humid
Efficient lighting	18-20%	18%	20-25%	15-19%	28%	28%	7%	4%
Reactive Power	9%	9%	9%	9%	9%	9%	9%	9%
Solar water heating	5-8%	1-4%	0%	0%	6%	19%	3%	3%
Shading							9%	9%
Natural Light			67%	67%			67%	67%
Energy efficiency AC							5%	7%
Transmission coefficient windows								4%
Reflectivity wall / roof								4%
Efficient Elevators								1%

The very high reduction potential of using natural light appears be an anomaly. Source: Resolution 549 / Sustainable Construction GuideComments under table, for e.g. references and explanations

Developers demonstrate their compliance with the MEPS through self-declaration and affidavit. Submitting the self-declaration is explicitly not a necessary condition for approving the housing design (Resolution 0549) and developers do not need to submit any documentary evidence substantiating their claim that they have followed the requirements of the guide (MinVivienda, 2017).

Table 10 shows the yearly energy savings and CO_2 emission reductions if all new housing built in one year would comply with the MEPS. These reductions need to be multiplied with the lifetime of the houses to estimate the total impact of applying the MEPS during one year.

Table 10: Expected energy saving and CO_2 emission reductions per year.

	Cold Climate			Moderate climate			Hot & dry climate		
	New buildings [10^3 sqm]	Energy savings [MWh]	CO_2 reduction [kt CO_2]	New buildings [10^3 sqm]	Energy savings [MWh]	CO_2 reduction [kt CO_2]	New buildings [10^3 sqm]	Energy savings [MWh]	CO_2 reduction [kt CO_2]
General housing	4584.0	3438.0	1063.7	3141.2	2355.9	728.9	2348.9	1761.7	545.1
Social housing (VIS)	1994.6	1595.6	493.7	1035.8	880.5	272.4	829.3	663.5	205.3
Social housing (VIP)	430.1	365.6	113.1	557.1	473.6	146.5	612.6	490.0	151.6

	Hot & humid climate			Total		
	New buildings [10^3 sqm]	Energy savings [MWh]	CO_2 reduction [kt CO_2]	New buildings [10^3 sqm]	Energy savings [MWh]	CO_2 reduction [kt CO_2]
General housing	1182.0	650.1	201.1	11256.2	8205.7	2538.9
Social housing (VIS)	389.1	311.1	96.3	4248.8	3450.9	1067.7
Social housing (VIP)	467.1	397.1	122.8	2066.9	1726.3	534.1

Note: The application of the MEPS is voluntary for social housing. The values here therefore show the maximum impact if all new houses would comply with the standards. Source: own calculations based on (Minminas, 2014; MinVivienda, 2015).

3.3.1.4 Ministry of Mines and Energy's (MinMinas) Policies for Energy Efficiency and Distributed Renewable Energy Generation

MinMinas, although not primarily responsible for housing or social housing, is responsible for the generation and use of energy and electricity. MinMinas has formulated a number of policies to promote energy efficiency in the residential sector and to enable the uptake and expansion of distributed renewable energy.

PROURE - Programme for the Rational and Efficient Use of Energy and Non-Conventional Sources

PROURE is the Colombian governments' main instrument to promote energy efficiency. It is based on Law 0697/2001 Regulatory Decree 3683/2003, which provide that the efficient use of energy is a national priority and establish relevant programmes, policies and guidelines. The PROURE's overarching objective is to ensure full energy supply, competitiveness of the Colombian economy, consumer protection, and the promotion of the sustainable use of non-

conventional energies. The planning and implementation instrument of PROURE are the Indicative Action Plans (PAIs).

First Indicative Action Plan (2010-2015)

The first PAI covers the period 2010-2015. It establishes concrete energy efficiency targets at the national and sectoral level as well as "strategic sub-programmes" and "sectoral sub-programmes" to achieve these targets. For the residential sector, the first PAI outlines the following savings potential and savings target for the sector:

- Savings potential: 10.6% of total electric energy consumption in the country, or 31.4% of electric energy consumption in the sector by 2015;
- Savings goal: 8.7% of total electric energy consumption in the country, or 25.7% of electric energy consumption in the sector by 2015.

Furthermore, the first PAI identifies five "priority sub-programmes" within the residential sector. One of them is "energy efficiency in social housing" (SR-4_Eficiencia Energética en Vivienda de Interés Social). Activities proposed in this sub-programme include:

- Development of energy efficiency norms for VIS and adoption of rules and regulations for buildings in line with climatic, environmental, and social conditions in different regions;
- Development of a concept for passive energy architecture for VIS;
- Promotion of investigation of sustainable construction, designs, material, appliances, etc. for VIS;
- Inform VIS owners on rational and efficient energy use through campaigns and interaction with providers of household appliances;
- Create a prepaid sales programme for electric energy at the national level for social housing;
- Promote pilot projects of associative and cooperative nature for groups who have problems to raise funds, high debt portfolios, and a lack of capacity to pay. These pilot projects should incentivise community purchase schemes for electric energy and promote change of habits, autoregulation, and rational energy use.

MinMinas and the Housing Ministry (under coordination of UPME) are responsible for the implementation of the sub-programme and monitoring of progress towards the targets e (Ministerio de Minas y Energía, 2010). No information on the results achieved under this sub-programme is available to date.

Second Indicative Action Plan (2017-2022)

The second PAI has recently been published, covering the period 2017-2022. It provides further insights into energy consumption patterns of the residential sector: in urban areas, central energy carriers are electricity and natural gas, with shares of 55% and 35% of total energy consumption, respectively. In rural areas, on the other hand, firewood continues to be the main energy carrier (77%), followed by LPG (14%) and electricity. In an urban environment, high shares of energy consumption can be attributed to refrigeration (39%), followed by television (20%) and illumination (10%). The second PAI furthermore states that inefficient equipment can

predominantly be found in households in strata 1, 2 and 3, that represent more than 85% of the population.

As is done under the first PAI, also the second PAI sets out a list of measures aimed at improving energy efficiency in the residential sector, including respective reduction potentials and several sector strategies to realise these potentials. It does not, however, provide an overview of the current status of measures and strategies proposed in the first PAI. It also does not set new energy efficiency targets for the residential sector(Ministerio de Minas y Energía, 2016).

Technical Regulations on Energy Efficiency

In the past decade, MinMinas has adopted three specific technical regulations in order to promote the rational and efficient use of energy. The three technical regulations will play a role in the future development of energy efficiency trends for housing. These regulations are:

- Technical Regulation for Lighting and Street Lighting (Reglamento Técnico de Iluminación y Alumbrado Público – RETILAP). Based on Resolution 181331/2009, the objective of this technical regulation is the establishment of standards for lighting and street lighting systems in order to ensure high quality lighting, security of energy supply, consumer protection, and protection of the environment.[29]
- Technical Regulation for Electric Installations (Reglamento Técnico de Instalaciones Eléctricas – RETIE). Based on Resolution 90708/2013, the objective of this technical regulation is to ensure the security of human life and to protect the environment, through minimising hazards of an electrical nature (this includes the establishment of conditions that avoid accidents through contact with electrical equipment; the prevention of fire and explosions caused by electricity; the adoption of symbols to be used by electrical engineers; the minimisation of deficiencies of electric installations; the creation of requirements to contribute to the rational and efficient use of energy and protection of the environment, etc.).[30]
- Technical Regulation for Labelling (Reglamento Técnico de Etiquetado – RETIQ). Based on Resolution 41012/2015, the objective of this technical regulation is to establish a labelling system for domestic refrigeration, air conditioning, single- and three-phase motors, ballasts for fluorescent lighting, and for washing machines, entering into force in August 2016. One year later, labels will be required for commercial refrigeration, electric and gas water heaters, unitary split air-conditioning, and household gas for cooking.[31]

Technical Regulation for Energy Efficiency in Social Housing (Reglamento Técnico de Eficiencia Energética para VIS – RETEVIS) – *Planned*

The Ministry of Environment shall establish, together with the Ministry of Energy, technical parameters for the efficient and rational use of energy in the design and construction of social housing, i.e. VIS and VIP. These parameters will be based on Decree 2501/2007, and build on already existing technical regulations RETILAP, RETIE and RETIQ. The new technical parameters

[29] See: The following link leads to the internet: https://www.minminas.gov.co/retilap (accessed: 07.02.2017).

[30] See: The following link leads to the internet: https://www.minminas.gov.co/retie (accessed: 07.02.2017).

[31] See: The following link leads to the internet: https://www.minminas.gov.co/retiq (accessed: 07.02.2017).

will address the gap created by the Sustainable Construction Guide, which is not obligatory for the social housing sector.

A legislative proposal for this technical regulation has been submitted. The Global Environment Facility (GEF) supports further elaboration of the legislative proposal. According to the proposal, measures to promote the rational and efficient use of electric energy should also be applied to products and processes in the sub-sector of social housing. Moreover, technical requirements outlined in the proposal are meant to be obligatory for all new construction in the social housing sector. However, the documents publicly available to date do not include concrete targets (Universidad de Colombia, 2010).

Regulation of Distributed Renewable Energy Generation

On 26 February 2018, the Colombian Energy and Gas Regulatory Commission (CREG) issued Resolution CREG 030 2018, which regulates the sale of surplus electricity back to the grid via net-metering for producers with a capacity of up to 100 kW and for distributed renewable generation for between 100 kW and 1 MW (Ministerio de Minas y Energia, 2018). The resolution simplifies grid connection for distributed energy sources that produce renewable energy primarily for the producer's own needs. The resolution regulates the grid connection of renewable energy installations, prices at which power is to be sold back to the grid, and response time of power distributors to connect systems to the grid. Local ESCO representatives expect the resolution to have a large impact on the residential PV market in Colombia.

Article 424 of the Tax Code does not explicitly exclude buyers of PV panels paying VAT. However, if PV is included in a project registered in the National Emission Reduction Registry (RENARE) to generate certified emissions reductions, the owner is exempted from paying VAT (Art 424-16).

Appliance Labelling

Colombia made energy efficiency labelling mandatory for various electrical and gas-powered appliances in 2015. Resolution 41012/2015 adopted technical regulations for labelling (RETIQ). These were slightly amended under Resolution 40234 /2017, which called for mandatory energy efficiency labelling for cooking appliances (MinMinas, 2017). UPME calculates that the RETIQ impact could amount to 2% of the total emissions of Colombia (UPME, 2015). The programme has some alignment with the US, Mexican, and EU labelling programmes. Technical Regulation for Labelling (Reglamento Técnico de Etiquetado – RETIQ) supports the appliance labelling programmes. It covers domestic refrigeration, air conditioning, single- and three-phase motors, ballasts for fluorescent lighting, and washing machines, and entered into force in August 2016.

Energy Subsidy Reform

Subsidies for electricity in Colombia account for 95% of the Ministry for Energy and Mining's total budget (Muñoz, 2016) - 2.6 Trillion Colombian pesos in 2015. Without a subsidy reform, the Colombian government expected increase in subsidies for electricity of 19% from 2017 to 2018. In January 2018, the Ministry announced that the subsidies for strata 1 would be reduced to 50% of basic consumption and subsidies for strata 2 would be reduced to 40% of basic consumption starting in March 2018 (Betín, 2018). This provides a small increase in the incentive for homeowners to conserve energy.

In 2016, due to particularly bad el Niño-related weather events, Colombia experienced droughts. As a result, hydro-electric capacity was severely limited, leading to electricity shortages. The government responded with incentives for increased energy efficiency for households that reduced their consumption below average use. Households with higher than average electricity consumption were penalised with higher bills.

Incandescent Bulb Phase-Out

The Ministry of Mines and Energy passed a resolution requiring the replacement of all incandescent light bulbs in public buildings by the end of 2007. The phase out was then gradually expanded to other sectors and the sale of incandescent light bulbs was banned after December 2010. The Mining and Energy Planning Unit (UPME) expects the ban on incandescent lights bulbs saves Colombia a total of 950 billion pesos or 47,000 tons of coal each day.

3.3.2 International Cooperation Supporting Energy Efficiency in Colombia

3.3.2.1 Climate Investment Funds / IADB Loan for energy efficiency

In 2013, the Climate Investment Funds provided Bancóldex a 10 million USD credit line, which will used to provide loans to hotels and clinics to make energy efficiency improvements. The project also included a capacity building programme for Bancóldex, local financial institutions, and other market experts, including ESCOs, to structure, finance, monitor, and evaluate individual sub-projects (Climate Investment Funds, 2013). The project was significant in helping to launch awareness and in structuring the ESCO business model in Colombia.

3.3.2.2 Energy Efficiency Green Bond in Latin America and the Caribbean

The IDB's Energy Efficiency Green Bond in Latin America and the Caribbean Programme provides for alternative financing for energy efficiency projects by issuing green Asset Backed Securities (ABS). The ABS pool and repackage climate-friendly projects for reissuance and are backed by the energy savings generated by the underlying projects (Green Climate Fund, 2015).

Projects like this IDB programme allow ESCOs to tap fixed income asset markets that offer more attractive financing terms than most bank loans. These latter are generally short-term, collateral-based loans based on the company's balance sheet and are generally not suitable for energy efficiency projects. Limited access to financing from local financial institutions is likely one of the largest and most common barriers to energy efficiency in Latin America and the Caribbean (Aldana et al., 2014).

The IDB expects this programme results in emissions savings of 13.2 million tCO2e in total, with on average 17 tCO2e reduced per $1000 invested. The GCF supports the ICB programme with a 2 million USD grant and 20 million ISD in guarantees and an additional guarantee from the Clean Technology Fund to leverage 780 million USD in privately raised investments.

3.3.2.3 Refrigeration NAMA

Colombia has submitted seven NAMAs to UNFCCC's NAMA registry so far. Of the three NAMAs currently under implementation, one NAMA in the domestic refrigeration sector is likely to have an important impact on electricity use in Colombia (Ecofys, 2017).

The domestic refrigeration NAMA focusses on the provision of technical and capacity building support for energy efficiency improvements in the housing sector. The NAMA includes the development of a replacement programme which includes a sustainable on-bill financing mechanism

with incentives for low-income households to purchase efficient appliances. This approach could serve as a prototype for other refrigeration and air-conditioning subsectors in Colombia.[32]

3.3.3 Sub-National Measures

In addition to efforts for the promotion of energy efficiency and renewable energy on the national level, various subnational measures have also been implemented.. Colombia's population is rapidly urbanising, so the efforts of subnational and the municipal governments in large cities are particularly influential.

Nine regional climate change nodes[33] that were established by Decree 298/2016 organise the coordination of national and subnational efforts. organised.

The main planning instrument for local governments to implement and enforce building codes is the "territorial ordering plan" or *Plan de Ordenamiento Territorial (*POT). All municipalities have a plan but these vary greatly depending on the size and capacity of the local government. The plans vary from basic territorial ordinance plans (PBOT) in small cities to territorial order schemes (EOT) in medium cities to territorial ordinance plans (POTs) in larger municipalities. These plans establish urban zones, land area for further development as well as rural and environmental zones and their specific land use. Some of them include urban projects including social housing, but not usually in detail.

In addition, city governments can define supplementary incentives/regulations for uptake of energy efficiency measures. The city of Bogota, for instance, had introduced an incentive through Decree 613 of 2015 to permit an increase in the area of construction if a building employed high sustainability considerations. However, due to limited advertisement among builders and design issues related to limited coverage of the incentive, it has not been taken up so far.

Two initiatives, one being implemented in Colombia's two largest cities, Bogota and Medellin, and the Swiss Energy Cities initiative in smaller cities are particularly worth noting.

3.3.3.1 Building Efficiency Accelerator (BEA) in Bogota and Medellin

The Building Energy Accelerator (BEA) is a public private partnership between the World Resources Institute and the United National Environment Program supported by the Global Environment Facility and Johnson Controls to promote energy efficiency improvements in buildings.

In Bogota, the BEA programme is helping the municipal government to adapt and implement the national Resolution 549 in the local context, specifically through the revision of the POT and master sewer and special planning tools. The Colombian Sustainable Building Council (CCCS) supports the implementation of the BEA programme implementation in Colombia. The new POT to be implemented with the help of the BEA programme will include two mandatory packages with targets for energy efficiency (see Table 11). Each package outlines prescriptive measures to achieve energy efficiency targets (among others). The city has not yet decided on making the targets mandatory for social housing. On the national level, these targets are voluntary.

As part of the BEA program, CCCS implemented a pilot programme to gather data through surveys with a larger sample to create a baseline for the city of Bogota. The city will use this new baseline (different from the baseline defined in resolution 549). In addition, CCCS and the

[32]See: The following link leads to the internet: http://www.nama-facility.org/projects/colombia-nama-for-the-domestic-refrigeration-sector/ (accessed: 02.02.2017).

[33] These nodes can be found in: Amazonía, Orinoquía, Centro Oriente Andino, Norandino, Eje Cafetero, Antioquia, Caribe e Insular, Pacífico Norte, y Pacífico Sur

Bogota government are working on a city level baseline to define building energy efficiency indicators (kWh/month) for all building categories.

A partial plan is a specific, sub-city level plan. It can be designed on need basis.

Table 11: BEA program's energy efficiency targets

	Minimum obligatory % efficiency improvement by building type in Bogota and estimated impact on direct investment costs as a result ofthe BEA programme		**Additional voluntary % efficiency improvement by building type in Bogota and estimated impact on direct investment costs as a result of the BEA programme**	
	Mandatory percentage energy saving	**Investment over direct costs**	**Percentage of voluntary emissions savings**	**Investment over direct costs**
Housing in strata 3 and 4	26%	1%	30%	1.63%
Housing in strata 5 and 6	26%	0.47%	30%	1.38%
VIP	17%	0.2%	21%	0.67%
VIS	22%	0.4%	30%	0.9%
Strata 3 and 4 comfort	N/a	N/a	31%	3.7%
VIP comfort	N/a	N/a	27%	3.9%
VIS comfort	N/a	N/a	32%	3.91%

Source: Res. 549 (top table) and presentations made by the BEA programme during project workshop.

Table 12: List of energy and water use reduction measures for VIS and VIP housing in Bogota pilot under the BEA programme

VIS	VIP
LED for interiors	Natural ventilation
Natural Ventilation	Natural lighting through facades and / or skylights
Water efficient showers	Water efficient showers
Efficiency in gas heaters	Conventional sanitary
Natural lighting through facades and / or skylights	LED for interiors
Occupancy controls in corridors and exteriors (lighting)	LEDs for outdoor
Sanitary saver	Dishwasher faucets

VIS	VIP
Efficient dishwasher faucets	Efficient dish washer faucets
Saver sink	Private sink
LED for outdoor	U value of outer walls
Sanitary double discharge	
Dishwasher faucets	
Private sink	
U value outer wall	
U value of glass	

Source: Based on presentations made by BEA programme in project workshop in March 2018

Through the implementation of the measures in Table 11: BEA program's energy efficiency targets

	Minimum obligatory % efficiency improvement by building type in Bogota and estimated impact on direct investment costs as a result ofthe BEA programme		**Additional voluntary % efficiency improvement by building type in Bogota and estimated impact on direct investment costs as a result of the BEA programme**	
	Mandatory percentage energy saving	**Investment over direct costs**	**Percentage of voluntary emissions savings**	**Investment over direct costs**
Housing in strata 3 and 4	26%	1%	30%	1.63%
Housing in strata 5 and 6	26%	0.47%	30%	1.38%
VIP	17%	0.2%	21%	0.67%
VIS	22%	0.4%	30%	0.9%
Strata 3 and 4 comfort	N/a	N/a	31%	3.7%
VIP comfort	N/a	N/a	27%	3.9%
VIS comfort	N/a	N/a	32%	3.91%

Source: Res. 549 (top table) and presentations made by the BEA programme during project workshop.

Table 12, Bogota expects energy improvements of 17-26%, with additional potential energy savings of around 30% through voluntary measures. The cost increase of obligatory measures is estimated to be below 1%; the additional cost of voluntary measures is expected to range from 0.9 to 1.63%.

3.3.3.2 Swiss "Energy Cities" Program

The pilot project "Ciudades Energéticas en Colombia" (Energy Cities in Colombia) aims to develop a sustainable energy policy on the city level in 2-3 pilot cities in Colombia, which could then be replicated across the country. Modelled on the "Energy Cities" initiative in Europe, the programme looks at measures to increase energy efficiency and enable cities to contribute to a wider energy transition in Colombia.

Six potential candidate cities were considered for the pilot: Girardot, Montería, Fusagasugá, Santa Cruz de Lorica, Pasto, and Cúcuta. Of these six, Pasto, Fusagasugá, and Montería were selected to participate in the pilot. The three cities will develop recommendations for upscaling their measures to the national level (HSB Noticias, 2018).

3.3.4 Private Sector Efforts to Promote Energy Efficiency

3.3.4.1 Bancolombia and Davivienda Green Bond for Energy Efficient Building

The international Finance Corporation (IFC) has helped private banks to float green bonds to finance sustainable housing in Colombia. In December 2016, Bancolombia, sold the 305 millon COP (approximately 115 million USD) Green Bond in the country's Segundo Mercado financial exchange. Bancolombia uses the capital raised by the bond to provide preferential interest rates for energy efficient buildings (IFC, 2017a).

Bancolombia and Davivienda, the largest commercial banks in the country, worked with IFC on issuing a total of 260 million USD in green bonds to support climate projects, including green buildings. Using capital raised from the bond issuance, Bancolombia provides discount interest rates to developers who build energy efficient buildings and to home buyers who buy energy efficient houses. Owners of energy efficient houses are likely to consume less energy and therefore have lower energy bills. As a result, these home owners are likely to have a higher disposable income and therefore be less of a credit risk. Thus, for banks it makes sense to provide discount interest rates to owners of efficient houses.[34] To qualify as a green housing project and thus be eligible for the banks' support, a building must obtain EDGE, LEED, or a comparable certification. For final consumer the preferential rate for 7 years is 11.3% annual percentage rate and the normal rate is 11.95%. The programme started in 2017 but has already financed two VIS/VIP developments. Davivienda issued a green bond of 433 billion COP (149 million USD) in April 2017. The capital that is raised by these green bonds, goes towards a financing programme similar to Bancolombia's programme (Climate Bonds Initiative, 2017a).

3.3.4.2 Net Metering

Although not widespread, there are several smart metering pilots in Colombia, including a pilot in Bogota that CONDESA started in 2013.[35] This pilot is currently being upscaled to more than 66,000 residential customers. And electricity consumers consuming more than 300 KWh per month. Smart metering facilitates MRV, net-metering programmes, and in the longer term, demand response measures that can help balance electric grid system loads and reduce emissions. In January 2018, the Ministry of Mines and Energy announced a strategy for a large-scale net meter roll out aiming to cover almost all customers by 2030. Energy consumers in strata 1,2, and 3 do not have to pay additional costs for the installation (Mouthón, 2018).

[34] Based on discussion with Bancolombia representative on 15 March 2018.

[35] More information on CONDESA's net metering programme can be found here: The following link leads to the internet: https://www.codensa.com.co/medidor-de-energia-inteligente

3.3.4.3 Private Sustainable Construction Standards in Colombia

A number of private building certification programmes are active in Colombia, including the International Finance Corporation's Excellence in Design for Greater Efficiencies (EDGE) programme, the US Green Building Council's Leadership in Energy and Environmental Design (LEED) standard, and the domestic Casa Colombia standard.

The Ministry of Housing and the Colombian Institute of Technical Standards (Icontec) are currently coordinating the development of a Colombian Environmental Seal for Sustainable Buildings (SAC – ES). The Ministry and Icontec work together with representatives from academia, trade unions, industry, and the public sector (H. Vargas et al., 2013).

3.4 Paris Compatible Mitigation in the Housing Sector

To be Paris compatible, the global building sector needs to decarbonise. Scenarios which are likely to limit global warming to less than 2°C require a 70–80% reduction of direct emissions from the building sector by 2050. In order to remain below a 1.5°C increase, steeper reductions of 80-90% are needed (Rogelj et al., 2015). To materialise this rate of reduction, countries will need to make fundamental changes to new buildings and renovate the already existing housing stock. Table 13 summarises the implications of the Paris Agreement on the sectoral pathway for global building sector.

Table 13: Implementation for the Paris agreement – implications for the Building Sector.

Indicator/ sub-sector	Implications of Paris Agreement for required pathway
Emissions (whole sector)	2 °C: Total GHG emissions would need to fall by 77% by 2050, compared to 2010 (IEA, 2012). This means a reduction of emissions by 3% on average per year (IPCC, 2014). 1.5 °C: Emissions would need to fall by 75-90% below 2010 levels by 2050 (Wouters et al., 2016). Direct emissions can be reduced by modifications in the buildings themselves, both building envelopes and heating/cooling systems installed (Wouters et al., 2016). Increasing the efficiency and share of renewables in the power sector can reduce indirect emissions, although end-use energy efficiency also plays a critical role (Wouters et al., 2016).
Emissions intensity (whole sector)	2 °C: The buildings related emissions intensity would need to fall by at least 80% by 2050. Building envelope improvements to reduce heating and cooling energy consumption will be critical (IEA, 2016b).
Renovation / Retrofitting	1.5 °C: Renovation rates would need to increase from the current 1% to 3% in non-OECD and by 5% in OECD countries by 2020 (Climate Action Tracker, 2016b).
New built	1.5 °C: New buildings would need to be zero-energy by 2020 in OECD countries, and by 2025 in non-OECD countries (Wouters et al., 2016).
Financing needs	2 °C: Financing this transition will require additional investments of 220 billion USD annually by 2020 (OECD; IEA, 2016).

Source: (Lütkehermöller, Day, & Röser, 2017)

Emissions from buildings can be categorised into embodied emissions and operating emissions. Energy consumption is the main contributor to operational emissions in buildings. These emissions are a consequence of building design, fossil-fuel based thermal and electrical energy use

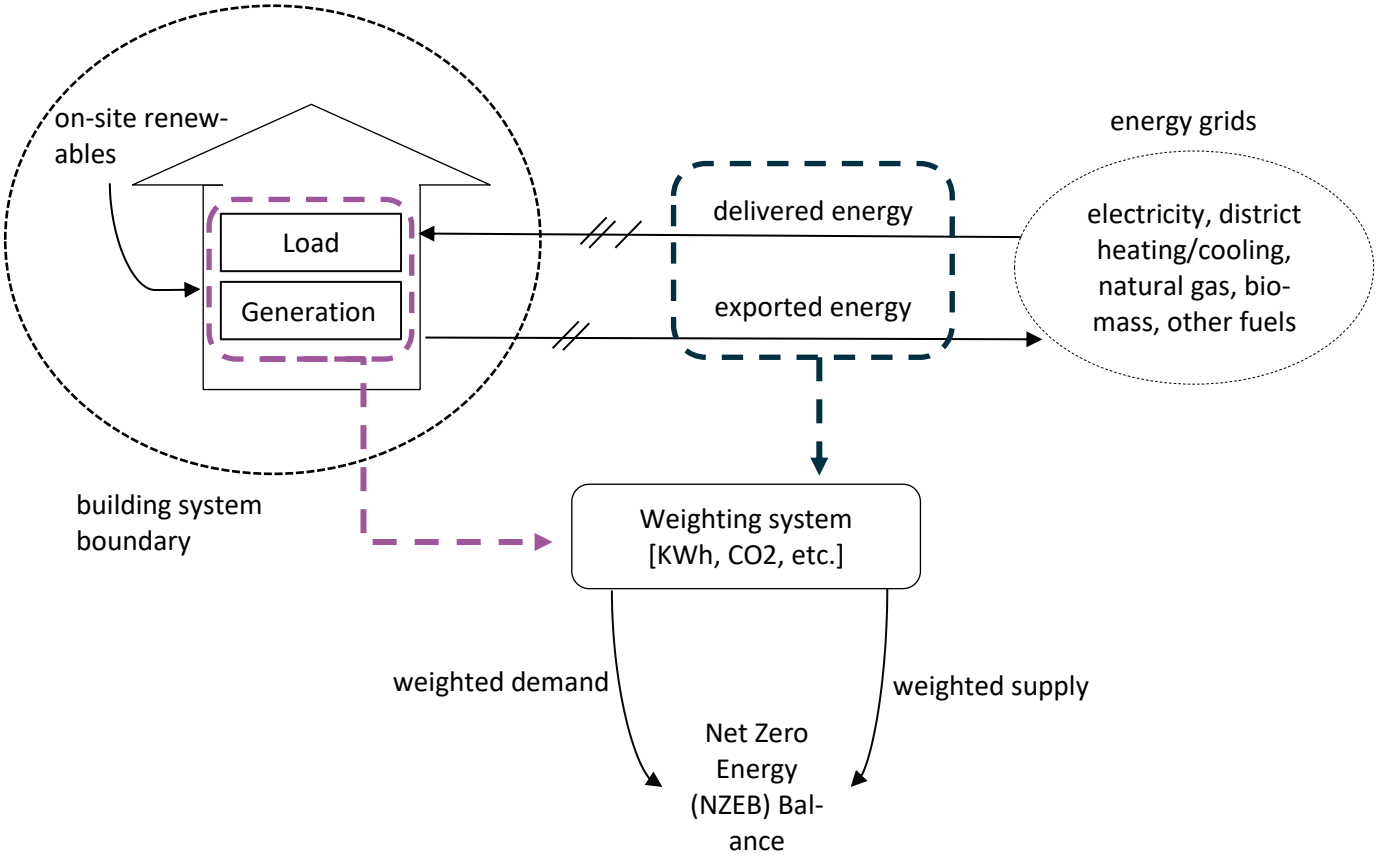
(for heating, cooking, appliances, lighting, refrigeration), and energy consumption due to behavioural and lifestyle choices. Four mitigation drivers can be identified for the buildings sector corresponding to these emission sources (Lucon et al., 2014): a) supply side measures (e.g. switching type of fuels used for power and cooling/heating); b) infrastructural efficiency increase (i.e. energy use reductions due to architectural, infrastructural, and systemic measures); c) technological efficiency (i.e. efficiency improvements of energy-using appliances, lighting etc.); and d) demand related emission reductions (e.g. behavioural and lifestyle changes to reduce energy consumption).

Keeping in mind the emission sources and mitigation drivers, sectoral decarbonisation will require reducing operational emissions from buildings to near-zero. Analysts recommend that all buildings built after 2020 in the OECD and after 2025 in non-OECD countries must have zero operational emissions, this needs to be complimented with a rapid renovation and retrofits in existing building stock (Climate Action Tracker, 2016a). To transform the entire current standing building stock before 2050, the current global retrofit rates need to triple within five years.

The concept of buildings with zero operational emissions is not new and has already been successfully demonstrated (IPCC AR 5). Zero-emission buildings use very little energy as a result of climate conscious design and use of highly-efficient appliances. Renewable energy generated onsite, provides zero-emission buildings with the required energy. When buildings inject as much energy into the grid as they consume, they are net-zero energy buildings (NZEBs) (see Figure 4). The ultimate mitigation potential for the Colombian housing sector is therefore to mainstream near-zero energy buildings in new infrastructure development.

Literature on mitigation potential in the Colombian housing sector provide a micro-level potential of individual mitigation measures. The sector is however highly dynamic and many options to increase energy efficiency are already underway. Most studies conducted so far have not evaluated the gap between the current situation and what it is required for decarbonisation of the sector. Several measures however are notable, particularly with regard to their negative overall costs. Several measures are already being implemented, both at smaller and larger scales.

Figure 4: Sketch of connection between buildings and energy grids showing relevant terminology.



Source: (Sartori, Napolitano, & Voss, 2012)

4 Potential Role for a Sectoral-Market Based Measure

This section explores the potential role of a market-based approach to greenhouse gas mitigation in the social housing sector in Colombia. We begin with a review of the theory of sectoral approaches historically. We then discuss the status of the carbon market discussions leading up COP 21, followed by an exploration of potential sectoral approaches under the Paris Agreement with a detailed analysis of environmental integrity, additionality, baseline setting, ambition, robust accounting, long term benefits, and sustainable development.

We find that an overall, large scale sectoral market intervention based on a fixed (sub) sectoral limit in keeping with the principles found in Article 6 of the Paris Agreement is not likely to be feasible. However, there may be a role for an ambitious pilot intervention for Net-Zero Energy Buildings (NZEB) on a limited scale to foster innovation and reward first movers. We describe what such a pilot could look like, a benchmark that would represent a crediting baseline, and an ambition trigger that, once reached would allow for generation of credits. We also identify a gap that represents necessary reforms in climate, housing, and energy policy in Colombia which represent relatively low hanging fruit that should represent Colombian "own effort", an approach that we further explore in section 5.

4.1 A Conceptual Overview of Market Approaches on a Sectoral Level

The "flexible" mechanisms under the Kyoto Protocol did generally not allow for sectoral interventions. International Emissions Trading was not necessarily associated with a specific measure but as a general economy wide trading regime, and the CDM and Joint Implementation were primarily single point project-based interventions crediting against a baseline. However, so-called programmes of activities (PoAs) under the CDM collected the emission reductions of smaller activities into scaled up interventions that could be supported through revenues from the sale of CERs. However, because the CDM is unable to radically scale up interventions and push a paradigm shift towards decarbonisation on the sectoral level, there are calls for the exploration of larger scale sectoral approaches.

The term "sectoral crediting" can be traced back to at least 2005 (Bosi and Ellis, 2005). Before COP21, some carbon market theorists conceptualised sectoral approaches as taking a number of possible forms inter alia (Baron, Buchner, & Ellis, 2009; M. Bosi & Ellis, 2005; Schneider & Cames, 2009):

- **Policy-based crediting**, where GHG-friendly policies in a particular sector could generate credits;
- **Rate-based crediting**, where efficient production below a certain GHG emissions level or below a certain intensity level (e.g. per product output or per value of output) would earn credits. In this case, no overall limit would be placed on the emissions from the sector;
- **Fixed sectoral limits**, where a sector could generate credits by performing better than an agreed fixed limit. This could take the form of either:
    - **Sectoral crediting**: where a no-lose target for a sector would be set, and improvement over a certain threshold would produce credits that could be sold on an international carbon market, but where failure to improve compared to the baseline would not lead to any penalties. In theory, a number of policies and or measures could be implemented to reach this target, either market or non-market based on the national level.

- **Sectoral trading**: where an overall emissions cap could be imposed on a sector, with allowances issued to emitters ex-ante.

It is worth noting that these approaches are not mutually exclusive. For example, policies or certain technologies could be used to overperform a sectoral target. In principle, an emissions trading system within a sector with allowances allocated ex-ante could be considered a policy which could lead to performance beyond a target. However current crediting mechanisms generally apply either pre-determined intensity or dynamic crediting baselines. Using a dynamic crediting baseline entails developing an algorithm or a model, and the absolute emission level of the crediting baseline is determined ex-post.

Performance thresholds or benchmarks (or the "GHG intensity level" in the rate-based crediting example) can play an important role in market-based interventions. Benchmarks are derived by assessing the environmental performance of a representative set of entities covered by a market-regulation and should be set more stringently than the average sectoral performance to encourage performance beyond the average. In sectoral trading, benchmarks could be used for free allocation of allowances to emit. For rate-based crediting, benchmarks set the performance level that an entity must surpass to receive credits. These benchmarks provide a transparent metric to standardise environmental performance in a sector/sub-sector and can be used as a tool to spur self-driven performance improvements among participants. Crediting thresholds can help avoid over-crediting in the event of an inflated BAU. Developing such a benchmark however can require significant upfront financial, technical, and human resources.

4.2 Sectoral Market-Based Approaches Before the Paris Agreement

Sectoral approaches have not been integrated into the institutional framework of the UNFCCC. Parties failed to come to a consensus regarding a future Kyoto Commitment Period at COP 15 in 2009 in Copenhagen, leading to uncertainties on the future of the Kyoto flexible mechanisms. At COP 17 (2011) in Durban, Parties "defined" "a new market mechanism" (NMM) and "established" a "Framework for Various Approaches" (FVA), but it never became clear what relation these new options had to the CDM, JI, IET, or indeed to the work of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) that laid the groundwork for what would become the Paris Agreement which covers the period after 2020.

Indeed, even after the conclusion of the work of the ADP to prepare the Paris Agreement, it was unclear up until very late in the negotiations at COP 21 in Paris if there would be any mention of market mechanisms at all.

A notable important difference between the Paris Agreement and earlier agreements, is that almost all countries agreed to make contributions towards the global effort.[36] Thus, under the Paris Agreement, transfers of units from one country to another will have an impact on both countries efforts to reach their GHG mitigation targets, which was not the case with the CDM (Spalding-Fecher, Sammut, Broekhoff, & Füssler, 2017)

4.3 Possible Consequences of Article 6 for the Colombian Housing Sector

The role of sectoral approaches under the Paris Agreement remains unclear. Article 6 allows for voluntary cooperation which could include "cooperative approaches" that generate "mitigation outcomes" with the potential for international transfer and for the establishment of a

[36] Syria is an exception. The United States agreed to make a contribution towards the Paris Agreement, however the current administration has backtracked on the commitment. Nicaragua first rejected the Paris Agreement as being too unambitious, but later joined.

"mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development". Article 6 also provides for a non-market approach to voluntary cooperation, but that option is not within the scope of our study. According to Article 6, voluntary cooperation can allow for higher ambition and promote sustainable development and environmental integrity.

For the purposes of this report, we understand both "cooperative approaches" and the "mechanism" to have the potential to generate internationally transferable mitigation outcomes that can be used towards the achievement of a NDC or towards another climate target and that can then no longer be used to demonstrate achievement of the Colombian NDC. In theory, both the cooperative approaches and the mechanism could be implemented to target a specific sector, however as of November 2018, Parties working in SBSTA have yet to further agree on even draft guidance or rules for international transfers.[37]

However, using the Paris Agreement and the associated COP 21 decision text, we can infer certain aspects of future market mechanisms and how a sectoral approach could fit in.

When engaging in cooperative approaches under Article 6.2, Parties shall promote sustainable development, ensure environmental integrity, and apply robust accounting to ensure the avoidance of double counting. Article 6.4 calls for the delivery of an overall mitigation in global emissions. The associated decision text (COP21 para 38) calls for real, measurable, and long-term benefits related to the mitigation of climate change, and that these reductions to be additional to any that would otherwise occur. The differences between Articles 6.2 and 6.4 are not yet clear and we do not speculate on the final outcome of these negotiations. Rather, we assume that the ability to transfer such units must conform to the principles of (at least) promoting ambition, sustainable development, environmental integrity, additionality, long term benefits, and robust accounting. Although not specifically referred to in the Paris Agreement, baseline setting is equally important and key criterion for guaranteeing environmental integrity and ambition. In the next sub-sections, we discuss what these principles imply and how they relate to a potential market-based intervention in the Colombian social housing sector.

As a non-Annex 1 Party for the purposes of the Kyoto Protocol, Colombia has so far mostly had experience as with the no-loss CDM baseline and crediting mechanism where instance of not achieving the foreseen emission reductions were not penalised. This experience was primarily based on specific project level interventions, not necessarily targeting a sectoral intervention or to support specific change in a sector.

Although Colombia has recently joined the OECD and is considering binding targets under a cap and trade programme for certain sectors, for the purposes of this study, given the high transaction costs of a cap and trade programme downstream at the household level (Coria & Jaraite, 2015) we will concentrate on a discussion of a theoretical baseline and crediting sectoral intervention, either on the sectoral level or through a rate based crediting approach.

4.3.1 Environmental Integrity

There are a variety of definitions of **environmental integrity** in Article 6 and carbon market related discussions, however the concept has been often defined as meaning that total global emissions should not increase because of the use of (crediting) mechanisms[38]. This overarching concept is related to a number of issues and ensuring environmental integrity in terms of GHG

[37] SBSTA/2018/L.12; FCCC/SBSTA/2018/L.13

[38] Such a definition should not necessarily be limited to crediting mechanisms, for instance for the linking of emissions trading systems, if an allowance from a system that has a cap (baseline) that is higher than business as usual is used for compliance in a system that is lower than business as usual, this would also lead to an increase in overall global emissions (Kachi 2015, Blyth & Bosi 2004).

mitigation would mean ensuring additionality of actions, setting robust baselines, promoting ambition / avoiding perverse incentives, and robust accounting. We explore these issues individually below.

4.3.2 Additionality

As mentioned, para 38 of the COP21 decision text defines additionality as "reductions in emissions that are additional to any that would otherwise occur". Baseline setting entails the construction of the most likely scenario in the absence of the incentives provided by the market intervention (Spalding-Fecher et al., 2017). These concepts are closely related to that of environmental integrity, since if a non-additional unit or a unit generated by an inflated baseline is used towards a mitigation target that would have otherwise been achieved by a real emission reduction, it would lead to an increase of global emissions. Additionality and baseline considerations are an important issue both on a project intervention level, as well as on the overall sectoral level. Equally, additionality and baseline questions are important for a baseline crediting option for a sector overall, for a GHG intensity benchmark on an output level, as well as for a binding cap and trade approach.

Whereas there is a broad consensus that additionality testing is required under project-based crediting approaches, there has been considerable debate about additionality in the context of sectoral crediting or policy crediting. A long debate is whether government policies should be eligible under crediting mechanisms. Although crediting policies has the potential to scale up mitigation measures and can have a bigger impact than crediting individual actions on a project level, policies are often introduced to pursue multiple objectives and whether or not they are introduced could depend on many factors that may not be related to the incentives from the crediting programme (Schneider, Fuessler, & Herren, 2014). This is a particular danger for policies in the case of social housing in general and particularly for Colombia considering the financial benefits that the government would have from reduced subsidy payments, reduced poverty, and improved health of citizens. Indeed, the Colombian government is already implementing many policies to improve energy efficiency in the building sector. Additionality for larger sectoral government policies is therefore even more difficult to ensure than for activities implemented by private sector entities (Schneider et al., 2014).

There are a number of issues to take into consideration when determining additionality and setting a baseline determination namely the existing incentives for and barriers against energy efficiency measures in the social housing sector without the market intervention:

Financial Additionality

Financial additionality, also known as investment additionality, directly assesses whether an intervention (either on a project or sectoral level) would take place without the financial incentive from the market intervention – if there are large potential cost savings or potential revenues in taking the action anyway, it is unlikely to be financially additional. This is often the case with energy savings measures. On an overall sectoral level, given the energy subsidies that the Colombian government pays for residents in social housing and their significant cost, the additionality of a sector wide policy is likely to be questionable.

On the level of an individual housing unit, there are however other factors that may constitute barriers to the project happening anyway in the absence of the intervention carried out by the project proponent funded through the sale of emission reductions. These may include split incentives, distortionary subsidies, lack of upfront capital, and long payback periods. We discuss these barriers and why in some instances energy efficiency measures may have an overall net

negative cost for an economy or a country but still encounter barriers on the individual housing unit level that, would not necessarily be overcome without the sale of emission reductions.

A classic split incentive problem is however often noted in the housing sector when the actor, such as a renter, who pays for energy use, is not in a position to make material energy efficiency interventions in the house which may be the purview of the house owner. This is not considered to be a major barrier in the case of Colombia because the Colombian social housing programmes in question are geared towards facilitating lower income groups to buy houses and become owner occupiers through the VIS/VIP programmes.

Many potential energy efficiency measures are best implemented in the design phase before a structure is built, which in theory constitutes a different kind of split incentive where the housing developer/construction company does not have an incentive to include energy efficient design measures because they are not paying for the costs of energy. Once a house is built, the best and cost-efficient opportunities to implement many energy efficiency measures may have gone unrealised. In Colombia, lower income groups who are eligible for social housing may not generally be aware or be in a position to exert influence over housing developers with regard to energy efficiency measures implemented in the design and construction phase of houses. Because of a general lack of choice of more energy efficient housing, construction companies do not generally yet have to worry that they will lose potential customers. It is therefore important and most cost efficient to provide an incentive for energy efficiency measures in the design phase. Overcoming such a (perceived) split incentive is related to the "circle of blame" described by Camacol discussed in the previous section.

Some financial incentive to build more energy efficient housing is provided in some cases through cheaper interest rates on both construction and mortgage financing (described in section 3). For example, as discussed in section 3, Bancolombia has a programme where the loan that housing developers get for energy efficient construction is a full percentage point better than the market rate for construction finance. In addition, homebuyers receive a 0.6% interest discount on mortgages for energy efficient houses. Davivienda, another large Colombian bank also has a similar program. Such initiatives provide an incentive for both the housing developer and the home buyer, including low income groups who qualify for social housing programmes to opt for a more energy efficient option.

The upfront costs of energy efficiency measures that house owners can take may also constitute a barrier on the individual housing unit level. VIS/VIP (social) housing is generally concentrated in the lower income strata 1 and 2 where their energy costs are heavily subsidised by the government, at least up to a certain threshold.39 This lowers the incentive for owner-occupiers to implement energy efficiency measures in their housing or to buy energy efficient houses. While energy efficiency measures lead to economic benefits in the medium to long term, high upfront costs may be significant in some cases, perhaps even prohibitive especially for lower income groups.

In such a case, a third party in a position to implement energy efficiency measures but who is not the beneficiary of energy cost savings (neither the government, nor the housing unit resident) may be motivated to implement energy efficiency measures exclusively through the financial incentive of carbon finance.

[39] See description of the strata system in Colombia in section 3.

Regulatory Additionality

A further question regarding potential carbon market intervention and the determination of the BAU baseline is the likely future of Colombian government policy in the sector. Or in other words, what would have been the intervention of the Colombian government in the housing sector in the absence of an opportunity to sell credits through a baseline and credit scheme? The additionality of policies, especially considering the existence and coverage of the residential sector under the NDC, is therefore a very complicated counter factual thought exercise (see next section on ambition for a discussion of what incentives the ability to trade may create for future policies).

A further complicating factor is that the energy performance of buildings, is influenced not only by policies from the housing ministry, but also from the energy ministry, as well as by policies and enforcement levels on the local (municipal) level. Even in the potential absence of future ambitious policies on the part of the housing ministry, the energy ministry or municipalities, especially cities like Bogota, Medellin, or Cali already are and are likely to continue to implement ambitious climate policies. These may not all directly be tied to a desire to emission reductions; rather there is a strong motivation on the part of the Colombian finance ministry and the national planning department to reduce energy subsidies that the Colombian pays to lower income households in the lower strata, which makes up for a significant portion of the energy ministry's budget. Other co-benefits such as reduced poverty, improved health, and other environmental benefits are important reasons why other policy makers from other ministries, agencies, and mayoral administrations may want to beyond any minimum standard set.

4.3.3 Baseline Setting

Similarly, in terms of baseline setting with regard to the future effectiveness of the policies of these two ministries, as well as the various sub-national (such as the BEA programme in Bogota) and private sector initiatives (such as the preferential interest rates for energy efficient construction from Bancolombia) makes baseline setting and therefore the future additionality of measures exceeding complicated.

The effectiveness of these measures, particularly because of the uncertainty of the baseline determined through for studies carried out for the Sustainable Construction Guide, introduces a further measure of uncertainty in that, depending on climate zone and local government implementation and enforcement efforts, the future energy performance of VIS/VIP housing may vary greatly.

The Colombian government further has a strong incentive to take ambitious measure to drive improved energy efficiency not only because of the many local sustainable development co-benefits mentioned in section 3, notably poverty alleviation, but also because of the significant subsidies that the Colombian government pays to low income households towards their energy bills. Savings on energy subsidies were described as one of the primary incentives for more ambitious government action regarding energy efficiency especially for VIS/VIP by workshop participants include representatives from UPME.

In addition to the measures outlined in Resolution 0549 and the sustainable construction guide and the various initiatives on the local level, the CONPES has also sets goals for all 'new buildings' to comply with defined sustainability criteria by 2030.

For baseline setting, the above aspects in addition to accurately predicting of technological developments, future population growth, construction rates for social housing, and associated demand for social housing which is affected by economic growth and social mobility present

further complicating factors. The "signal to noise" ratio in terms of a market intervention vis à vis other developments in the sector are very hard to quantitatively assess.[40]

4.3.4 Ambition

As noted above, the Article 6.1 states that ambition raising is of key concern and Article 6 should contribute to this goal whether through a sectoral approach or otherwise. Given the ambition imperative of the article and the prospect of the need for Colombia to ratchet up its NDC, any Article 6 participation should also contribute to transformative change in the building sector (building practices, behaviour change, etc.) that facilitate more ambitious Colombian NDCs in the future. In the context of Article 6, ambition may me understood as interventions that "channel investment to areas that genuinely represent areas that would otherwise be out of the country's reach" (NewClimate Institute, 2018). Considering the Paris Agreement's process of ambition ratcheting through the global stocktake and progressively more ambitious NDCs, it is in the interest of all countries to keep their cheapest in country mitigation options for themselves. Ideally, and market-based intervention would lead to transformational change and lead to investments that are significantly better than a business as usual baseline and that are in line with a trajectory towards complete decarbonisation.

Although Colombia, as of May 201841 had not yet communicated a long term GHG decarbonisation strategy, in order reach the temperature goals of the Paris Agreement, deep decarbonisation in all sectors including the housing sector is a necessity (Climate Action Tracker, 2016a). Further, given the qualitative and quantitative deficit of affordable housing in Colombia, improving the energy efficiency of energy using equipment and buildings has the further major added co benefits of poverty alleviation in that it can eliminate fuel poverty (Ürge-Vorsatz & Tirado Herrero, 2012), and improves government fiscal budgets by reducing subsidy payments under the strata system. Decarbonizing social housing in Colombia also does not present the same barriers as it may in some other countries considering the fairly temperate climate of cities where social housing is concentrated and is expected to be in future demand like Bogota without cold winters or hot summers. Many energy efficiency measures in the residential sector and especially social housing are likely to be comparatively cheap mitigation options that Colombia may prefer to keep for its own NDC achievement.

In talks with Colombian government officials42, it was made clear that any reductions produced as a result of engagement through Article 6 must not only avoid double counting with the Colombian NDC, and the acquiring country NDC, but also result in additional emission reductions, a percentage of which would go towards the Colombian NDC and a percentage of which could be transferred internationally.

The design of any intervention however must also take care to avoid perverse incentives which may undermine ambition raising by Colombia. The willingness of a buyer to purchase reductions from a certain baseline may lead to a perverse incentive to: inflate the baseline so as to increase the number of reductions possible below it; to not take other action to achieve the reductions so as to assure that the external purchase of reductions are necessary to achieve the reductions; or indeed take action to increase emissions that would otherwise occur in order to have them

[40] For a further discussion on additionality and environmental integrity and "signal to noise" see for example Spalding-Fecher et al (2017). Environmental integrity and additionality in the new context of the Paris Agreement crediting mechanisms. Carbon Limits. Available at: The following link leads to the internet: https://www.energimyndigheten.se/contentassets/2600659ecfa54ec995b835a4c99d75fb/environmental-integrity----final-report-2017.01.24.pdf

[41] Current submitted strategies can be found here: The following link leads to the internet: https://unfccc.int/process/the-paris-agreement/long-term-strategies

[42] Meeting with Colombian Government officials on 7. May 2018.

reduced through the market mechanism intervention. Referred to as the E+ policies that would lead to emissions increases and E- policies that would decrease emissions, a tentative solution to such incentives was found in the CDM but has not yet been addressed under the Paris Agreement. In practice, considering the co-benefits and financial interest of the Colombian government to reduce energy subsidy payments while alleviating poverty, such perverse incentives in this case are not likely to play a significant role in government decision making.

4.3.5 Robust Accounting

COP 21 decision text para 37 calls for double counting to be avoided for 6.2 – cooperative approaches "on the basis of a corresponding adjustment by Parties for both anthropogenic emissions by sources and removals by sinks covered by their nationally determined contributions under the Agreement". Effectively similar text is found in Article 6.5 referring to the 6.4 mechanism namely that "Emission reductions resulting from the mechanism … shall not be used to demonstrate achievement of the host Party's nationally determined contribution if used by another Party to demonstrate achievement of its nationally determined contribution".

As previously discussed, the overall single year target for 2030 is a 20% GHG reduction from the national projected BAU scenario and is further subdivided into 20% reductions among the line ministries, including the housing and energy ministries. With international support, Colombia states it may be able to increase its target to a 30% reduction by 2030. The domestic accounting challenge that this creates has been previously discussed, however on the global level, Article 6 requires further accounting and tracking in keeping with the principle of avoiding double counting, emission reductions should not be simultaneously used towards the Colombian NDC as well as an acquiring country's NDC. Globally, this may be a technical challenge, given the diversity of NDCs and their timeframes, coverage, GHG calculation methods including GWP, and formats (Graichen, Cames, & Schneider, 2016). Colombia has been explicit with regard to the definition of the Business as Usual scenario that it bases its reduction commitment on and its NDC can be interpreted as an economy wide target. The NDC target as formulated is a single year target, however given the Colombian interest in engaging in international market approaches, it may wish to consider converting the into a quantified target, which could facilitate with international transfers for countries that represent potential buyers of ITMOs on an accounting basis (Barata & Kachi, 2016).

Accounting however becomes another issue because the timing of a possible emissions transfer and the risk of over transferring. This is to some extent related to the timeframe of the NDC in that a corresponding adjustment must be made based on inventories, but inventories are conducted every two years, while the global stock take is every five years, and currently both the Colombian and EU NDCs for example are for 2030. Colombia may be reluctant to allow for transferred mitigation outcomes unless it is very clear that it is well on track to achieving its NDC. If close attention is not paid with regard to the mitigation outcomes transferred, when the NDC compliance horizon approaches, Colombia may find itself in a position of needing to buy back credits to achieve its NDC. Depending on the guidance or the rules, of the transfer, mitigation outcome may not be eligible for transfer until it is clear that Colombia has achieved its NDC, which may not be clear until after 2030. If investment to fund the energy efficiency are needed now, this is a significant risk for either Colombia or the acquiring country regarding clarity about when the credits are transferred and how this relates to each NDC.

4.3.6 Long Term Benefits

Although also not clearly defined, long term benefits may in some cases relate to the issue of the permanence of emission reductions in cases where there may be a reversal of the emission

reductions such as in the case of temporary sinks. It may however also relate to longer term issues and the potentials of lock-in of future emissions. This may become an issue, for example in cases where an intervention may lead to marginal emission reductions beyond a certain alternative scenario, but also represents a potentially long-term investment which does not lead to, and potentially delays or hinders decarbonisation. The long-term benefit criterion of the Paris Agreement can be interpreted to mean that, international market-based interventions should not lead to outcomes that would lock in long term emissions. Given the long life of building and housing assets, this is a particular problem with in the housing sector (Lucon et al., 2014).

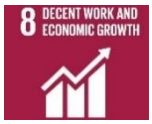
4.3.7 Sustainable Development Impact

Although the exact definition of sustainable development and how it should be measured is a subject of intense debate within the context of Article 6 negotiations, United Nations General Assembly Resolution A/RES/70/1 of 25 September 2015 sets out the 2030 agenda for sustainable development with 17 goals (SDGs) and 169 targets to reach those goals.

For developing countries like Colombia focussing efforts on decarbonising new buildings is a necessity to achieve the SDGs and in its own interest because:

1. Colombia estimates it needs to build 3.9 million new homes by 2019 to stabilise its current housing deficit and meet housing demand of the growing urban population. Already 76% of Colombian population is urban dwelling. This number is set to rise to 85% by mid of this century.
2. 80% of Colombian population falls in the lowest housing strata (i.e. strata 1 and 2) which gets power and fuels at heavily subsidised rates. Lower energy use in lower strata particularly will lower the costs of government subsidies.
3. Even with government subsidies, in certain areas the cost of energy can make up a significant burden accounting for a significant portion of lower income family salaries, perpetuating poverty;
4. Early action on new buildings checks for emission growth in both buildings and energy sector.
5. Disadvantaged income groups are more likely to suffer from negative health effects of poorly built housing and suboptimal temperature regulation - building sector mitigation positively impacts on 10 of the 13 sustainable development goals.

Figure 5: Illustration of selected synergies between SDGs and typical measures for climate action on energy efficiency

Sustainable Development Goals (SDGs)	Typical measures for climate change action on Energy efficiency in buildings and industry and linkages to SDGs
	↑ Reduce household energy bills / alleviation of energy poverty.
	↑ Reduce indoor air pollution and sick building syndrome.
	↑ Enhance conditions for learning.
	↑ Successful introduction of programmes for reducing emissions depends on empowerment and participation of women in the household. ↑ Increased accessibility for marginalised groups and people.
	↑ Reduce energy consumption and bills.
	↑/↓ Creation of decent jobs and new industries. (Depends on policy options to avoid adverse outcomes of job losses in older industries.)
	↑ Improve efficiency and competitiveness of industry.
	↑ Energy expenditure burden is greater for lower income groups.
	↑ Investments extend useable lifetime of built environment.
	↑ Decarbonise cities; improve resilience to extreme weather.

Source: adapted from (Day et al., 2018)

4.4 Summary of Challenges for a Sectoral Market-Based Intervention

In addition to the general barriers to mitigation inherent in the sector discussed in Chapter 3, there are specific barriers to the implementation of a sectoral mechanism. For the calculation of a baseline of the sector as a whole, robust MRV data on current emissions in various climatic zones would be needed.

Understanding of actual use and not assumed modelled use can be important as energy use is not only a function of government policies, but also significantly a function of the occupants of a house, their habits and significantly a function of the kinds of appliances they use. Behavioural inertia or changes may lead to tendencies in the profile of energy use that is unrelated to government policies or the efforts of architects/construction companies.

Some data has been collected for the development of the Resolution 549 and the Sustainable Building Guide, but standards for data collection for a crediting mechanism with environmental integrity are likely to be much more granular and complicated. Such data is currently not available and survey efforts to collect such data are associated with high costs, which may be better spent implementing other energy efficiency measures in the sector (Karavai, Lütken, & Puig, 2018).

As discussed above, guaranteeing the environmental integrity of an overall sectoral approach that credits marginal improvements in Colombia is very challenging, especially with regard to predictions of regulatory additionality on various levels and robust baseline settings. It would also lead to further emission lock in, or future more expensive retrofitting efforts to drive mitigation benefits.

Further, given the relatively low emissions factor of the Colombian electricity supply, improved energy efficiency in terms of electricity use per kWh will not reduce large amounts of emissions. This increases the per tonne upfront cost of energy efficiency measures, even if these are associated with negative costs in the medium term. Calculations carried out by the project team indicate that marginal improvements such as those listed in the Sustainable Building Guide may produce low emission reduction volumes of well below one tonne of reduced emissions per social residential housing unit per year. This is due to the relatively small emissions of each unit: social housing in Colombia typically does not have a heating or cooling system; cooking is responsible for over half of the total energy consumption. Together with the low grid emission factor for electricity a typical social housing unit only causes emissions of around 600 kg CO_2/year. Given the variety of measures that may be necessary to reduce such energy usage, per tonne reduction costs may be extremely high in up front terms and associated with high transaction costs. On this basis, it is unlikely that reductions to be found in the Colombian social housing sector would be able to compete with other mitigation options in international markets at current prices.

4.4.1 Market Supply and Demand

It is yet unclear if a global liquid carbon market will develop after 2020. While there are various sources of demand including the new Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Organization and NDCs, a large majority of countries that have said they would participate in markets are likely to want to sell rather than buy credits and most countries that have explicitly stated they will buy credits are not large emitters (Kachi et al., 2016), any demand projections for mitigation outcomes over the 2020 to 2030 or even 2020 to 2025 period are likely to be highly speculative. If there is a future liquid fungible market, there is the possibility of a large over supply of credits in the post 2020 period, especially if credits such as CDM credits from the pre-2020 period can be used after 2020 (Fearnehough, Day, Warnecke, & Schneider, 2018; Schneider et al., 2017). Such oversupply

would lead to low prices on international markets which may make higher per tonne cost interventions such as energy efficiency in Colombia likely unfeasible if they were to compete in the same terms.

4.5 Conclusions Regarding an Overall Sectoral Approach

The provisions of Article 6 and the associated barriers make a policy crediting approach very challenging, especially in terms of environmental integrity. Similar challenges are found with an overall sectoral limit-based approach either through crediting or trading. Further, even if environmental integrity concerns could be overcome, it is highly unlikely that current or foreseeable short to medium term global prices could mobilise sufficient finance to drive investment at scale.

However, international support for a rate based crediting approach on a project basis with an ambitious benchmark that avoids high carbon lock-in through a market mechanism may be available on a bilateral basis where the purchase decision of the acquiring partner may be motivated by factors beyond cheapest possible emission reception potential. Specific measures on a project level, may still be justifiable and help contribute to transformation of the sector. In the next section, we describe a proposal for a pilot measure for net zero energy buildings (NZEB) that could use ambitious benchmarks to increase environmental integrity, is very likely to be additional, maximise sustainable development co-benefits, have long term on future emissions and promote sectoral transformation.

4.6 Proposal for a Net Zero-Energy Building Pilot for Social Housing in Colombia

Based on extensive desk research, interviews and workshop with relevant stakeholders it is clear that the Colombian government and other actors, public private, national and subnational are and will take efforts to increase the energy efficiency of buildings and housing, including social housing. So far, measures have however not been in line with and or targeting a decarbonisation of the housing sector. We therefore propose a pilot to implement a Net Zero Energy Buildings programme for social housing. The pilot would not only reduce emissions of the buildings that are included in the pilot, but to also have a positive spill over effect into general housing construction practice.

4.6.1 General Description of the Proposed Pilot

Mainstreaming net-zero energy buildings is a worldwide necessity for sectoral transformation in the building sector to achieve the goals of the Paris Agreement. There is a strong case for incorporating sustainable design and energy efficiency considerations in the new residential infrastructure development underway in Colombia. The current momentum for infrastructure creation especially housing demand in the social housing segment presents an opportunity to test approaches to quantify, monitor and reduce emissions at least on the building unit level compared to local comparable practice in a specific area. The social housing segment is particularly promising due to high political buy-in, strong involvement of the government with dedicated subsidies to promote house ownership and as well as subsidies for energy consumption, and high social impact of such interventions. Promoting low-carbon development in the building sector could avoid future emissions lock-in, provide numerous co-benefits notably poverty alleviation and improved health to residents and positive effects in upstream sectors such as power generation. As discussed however, an overall sectoral approach is challenging. There is a lack of implemented examples to present a value proposition for focussing mitigation on low-income housing.

Towards this end, a pilot programme that promotes development of net-zero energy social housing units in selected municipalities could serve a pioneering role in Colombia that is so far lacking and is unlikely to occur on its own. A net-zero energy building is one that consumes no net energy from the grid over a given pre-defined period of time (i.e. monthly/annually). For this, first, the building must be designed to reduce energy demand for heating, cooling and lighting to the extent possible. Additionally, energy demand should be further reduced by use of energy efficient appliances. The remaining energy needs should then be covered by own renewable energy produced on-site. Implementing net-zero concepts to new buildings provide a useful starting point for introducing net-zero energy concepts.

The Net-Zero Energy Building (NZEB) pilot is a prospective opportunity to use international cooperation under Article 6 of the Paris Agreement to develop new net zero energy VIS and VIP residential buildings in selected cities in Colombia. Examples of zero-energy buildings are not apparent in Colombia in general and likely non-existent in the social housing sector. The NZEB pilot initiative in the social housing segment is aimed to pioneer the concept and introduce novel technologies/approaches necessary for net-zero energy in the Colombian market. Examples elsewhere show the critical role of pilots or demonstration projects in inducing market interest, promoting further uptake and creating domestic production supply chains. The NZEB pilot would be a voluntary programme that accelerates sectoral developments and informs policy developments towards the ultimate objective of mainstreaming net-zero energy housing in Colombia.

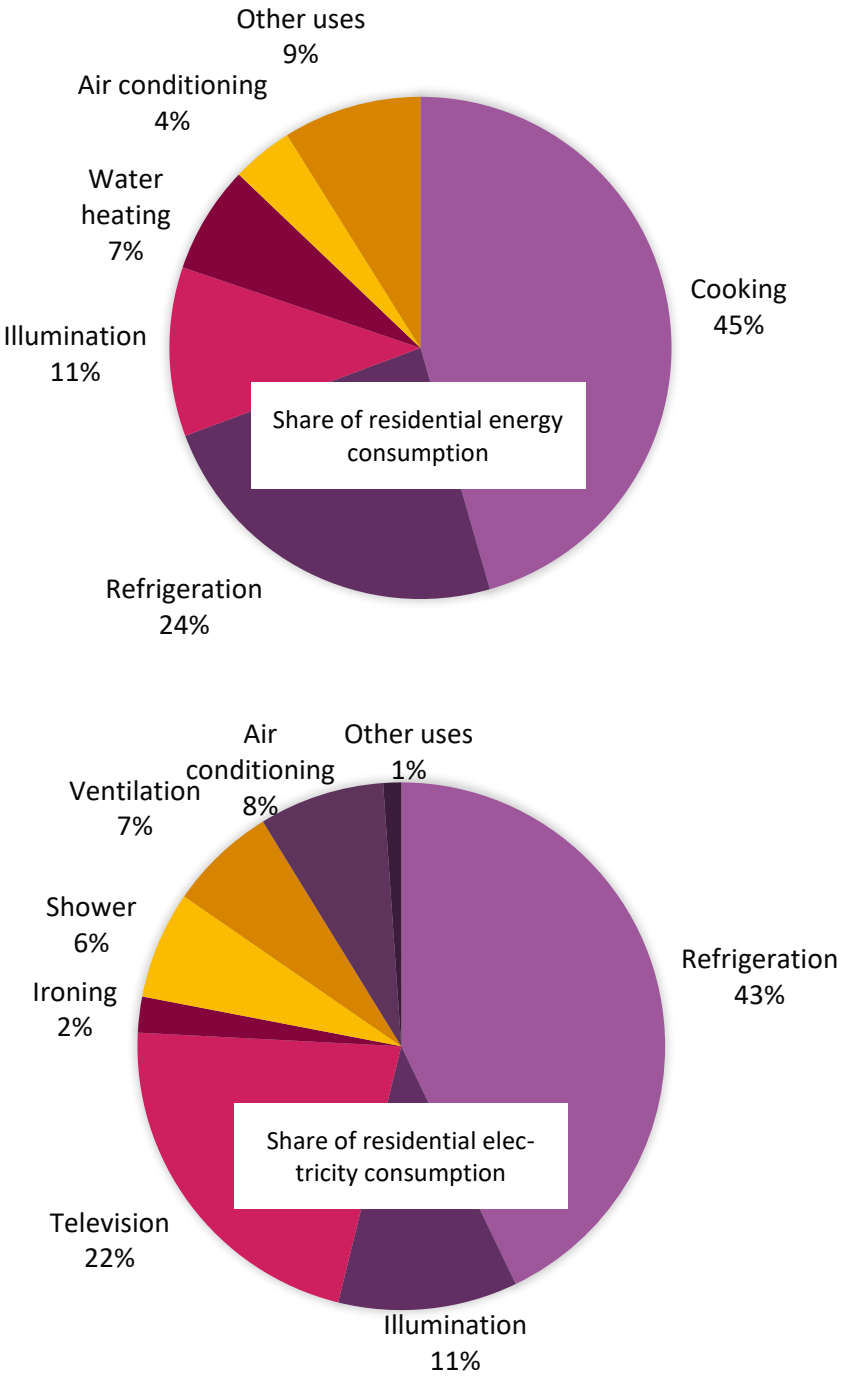
4.6.2 Technical Description of Typical Activities Under the Program

The NZEB Pilot programme will apply a whole-house approach in energy efficiency improvement in individual new social housing units. A whole -house approach moves away from individual measures for energy performance improvement such as efficient lighting, solar water heating etc. Rather a systems approach is taken for improving the energy performance of the house as a whole, wherein a house is conceived as system of interconnected energy use sub-systems (e.g. lighting, appliances, HVAC systems), each of which affects the performance of others.

Colombia's second sectoral action plan (PAS-II, 2017-2022), the key energy efficiency policy - Programme for the Rational and Efficient Use of Energy and Non-Conventional Sources (PROURE) provides detailed estimates of energy consumption distributed by use in the urban residential sector in Colombia.

The main energy consumption sources are refrigeration, television, lighting and cooking. In terms of fuels, electricity has a 55% share and natural gas (mainly for cooking) a 35% (UPME, 2017). According to local interviews, social housing rarely includes heating or air-conditioning (Figure 6).

Figure 6: Energy and power consumption in the urban residential sector of Colombia



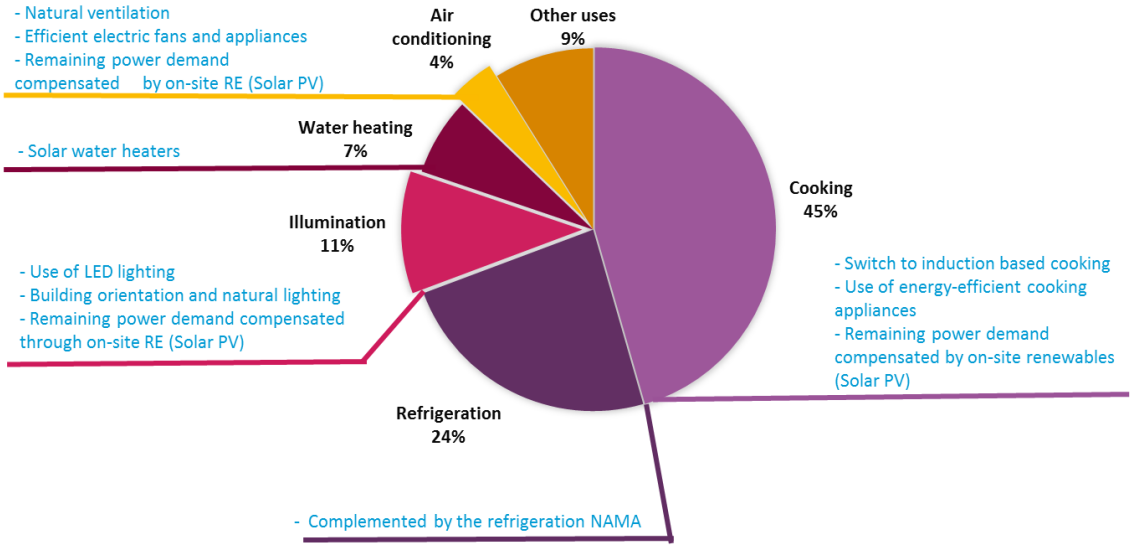
Source: (UPME, 2017, p. 39)

The technical mitigation measures to improve performance of social housing in Colombia to net-zero energy in the pilot should focus on two dimensions. First, to pilot new residential VIS, VIP housing units which are highly energy efficient in design and energy use. Second, include renewable electricity technologies such as solar panels and solar heated hot-water to compensate for residual energy demand over a monthly/annual cycle. Based on the energy consumption profile of the sector and measures discussed in ongoing initiatives, the following broad measures would need to be considered for a net-zero energy house:

5. **Passive measures** – Passive measures have to do with the civil-architectural aspects of the design of buildings. These characteristics determine the manner, form and details of the building envelope that are directly related to its energy efficiency. Some examples of mandatory passive measures that can be included are:
    k) Natural lighting through facades and/or skies;
    l) Natural ventilation to reduce a building's energy consumption load;
    m) Building orientation to reduce heating/cooling load; and
    n) Building insulation. Building insulation is measures as U-value of outer walls, roof and windows. U-value provides an assessment of the level of insulation in the building. The best insulating materials have a U-value of close to zero; the lower the better.
6. **Active energy efficiency measures** – These deal with the equipment installed or that would be sold with the housing unit for heating/cooling, cooking, lighting etc. and deal with improving energy efficiency of equipment to reduce a building's energy demand. Active measures include those for:
    o) Lighting – e.g. LEDs for interiors, LEDs for outdoors and occupancy controls in corridors and exteriors. The penetration of LED lighting was slower in low-income strata houses (UPME, 2017) however this is likely to have changed with recent price developments of cheaper LEDs.
    p) Appliances – This relates to use of energy efficient appliance in a house, e.g. refrigeration, ironing, television, cooking appliances, computers, etc. This however represents a challenge because VIS/VIP houses are sold without appliances. Selling VIS / VIP housing units with appliance would increase the cost of the housing which would pose a challenge considering price caps for these housing units. See pilot funding for an ESCO model where the ESCO would own and lease appliances.
7. **Fuel switch from natural gas to electricity for cooking** – Currently, 50% of energy use in Colombian urban households is from cooking. Natural gas is the main cooking fuel, followed by a small proportion of LPG and electricity. Shifting from natural gas to power as the cooking fuel is necessary for achieving the net-zero energy status. To maximise the energy use, highly efficient stoves, such as induction stovetops, which cook with up to 90% efficiency should be promoted (Sadhu, Pal, Bandyopadhyay, & Sinha, 2010).
8. **Installation of low-carbon energy generation technologies.** Two critical technologies towards net-zero house are:
    q) Solar Water Heaters (SWH) to meet the thermal energy load for hot water
    r) On-site solar PV for meeting the remaining power demand of an energy efficient house.

The role of individual measures towards reaching a zero-energy house in Colombia are summarised in the schematic below.

Figure 7: Summary of mitigation measures in major energy use categories for net-zero energy houses



Source: (UPME, 2017, p. 39)

4.6.3 Location of Activities

Such a pilot could be developed in urban social housing in Colombia. Considering the ambitious nature of the project and sectoral dynamics in Colombia, the cities and municipalities chosen for the pilot should fulfil certain criteria, such as:

- future social housing demand hot-spots such as the greater Bogota metropolitan area, Medellin, and/or Cali, which represent over 50% of expected population growth in Colombia to 2030.
- areas where energy (both electricity and gas) prices are high for even low-income strata. Stakeholders suggested the coastal cities of Barranquilla and Cartagena as potential options.
- cities with highest political buy-in, especially those that are developing or implementing climate change plans including mitigation targets.
- good local planning in place to facilitate regulatory action, and have the potential to integrate NZEBs into long term planning (e.g. capacity to elaborate and include energy efficiency measures in "*Planes de Ordenamiento Territorial*" (POTs)).
- where good potential exists for involvement of local architects/universities in design of buildings (e.g. through design competitions).
- those where prominent promotional opportunities already exist.

4.6.4 Demonstration of Environmental Integrity and Ambition

Although marginal improvement of energy efficiency in the residential housing sector are currently being implemented and may accelerate in the future, NZEB as a concept and package of measures that lead to the decarbonisation of the operational emissions of a housing unit is

currently non-existent in the Colombian housing sector, including in social housing. Colombian energy and housing policies are in the process of reform and ratcheting, however (as is the case in many countries) not yet on an overall trajectory towards decarbonisation, something that has been expressed as a policy goal primarily in California and the EU starting in 2020. Reducing the operational emissions of a residential housing unit to zero can reasonably be said to go far beyond current practice and what would otherwise happen in the Colombian social housing context. A conservative approach to crediting baseline setting based on an ambitious benchmark (see below) can set and incentive for further ambition while safeguarding against over crediting.

4.6.5 Contribution to Transformational Change

The proposed pilot aims to introduce the concept of a net-zero energy building to Colombia specifically for the social housing (VIS / VIP sector). NZEB are not common current practice in Colombia, even for higher-end residential or commercial buildings. Especially given the perceived extra cost of an NZEB compared current practice, construction companies active in building social housing in Colombia do not have experience in NZEB techniques, and have not explored cooperation with ESCOs, and generally do not consider the longer term operational energy needs of housing beyond what is required by Resolution 549, though results have not been verified ex-post.

The pilot will leverage experience from Europe and California to introduce the idea and build capacity among architects, construction companies, finance institutions, and housing buyers about the concept of NZEB and actual costs and benefits. With increased scale, costs are expected to decrease while the pilot is only expected to last for a limited time to support ambitious early adopters.

Further the pilot is expected to foster technology transfer and penetration to mainstream building practices and relevant technologies such as heat pumps, photo voltaic panels, and solar hot water heating in Colombian social housing and the Colombian residential and building sectors more generally.

4.6.6 Performance Monitoring

A monitoring plan is necessary to be able to report and verify achieved reductions in energy consumption and GHG emissions. Two different approaches to collecting the necessary data are possible:

- **Measurement:** if it is possible to gain reliable access to the billing data or meter readings actual energy consumption can be measured directly. Such an approach will normally provide high quality data because meters need to be calibrated and billing information tends to be correct. Getting access to such data can be problematic and approaches relying on the repeated voluntary cooperation of owners (e.g. annual surveys) have proven to be difficult in other countries (e.g. see the discussion on the Mexican NAMA in section 5). However recent changes to the net metering legislation may help measure the energy use of housing units that have installed PV panels.

- **Modelling:** Instead of measuring energy consumption directly it is also possible to model the standardised energy demand for a building and its location. The advantage is that such an approach does not rely on ex-post data which might be difficult to obtain. The quality of the modelled energy consumption strongly depends on the quality of the model and assumptions on usage patterns.

Both approaches can lead to reliable results and are used in different countries. For large projects it might be sufficient to only measure/model a sample of the total number of houses but in such cases it is crucial to ensure that the selected sample is representative of the total project. The modelling approach relies on a strong enforcement and quality control: if energy saving measures are modelled but not implemented (correctly), the modelling results will overestimate potential savings. A hybrid approach is to model energy savings but calibrate/cross-check the modelling results with measured data. Either approach can be implemented and depends on the feasibility and available resources.

4.6.7 Duration of the Programme

It is critical that support for Article 6 programmes lasts for a limited time period, after which the voluntary action should make way for independent action by a country to support or regulate further technology uptake (NewClimate Institute, 2018). Therefore, the continuation of such a pilot programme should be regularly reviewed. Two aspects are important to consider in such a review:

a) Length of the overall programme

Initially, a few demonstration projects would be selected for the program. Further project proponents interested in participating could have a window of opportunity to participate in the pilot be limited for an initial five-year term 2024/2025, in keeping with the NDC cycle, to be reviewed and updated with a new benchmark for the period 2025-2030. For instance, for future buildings / continuation of the programme, after every five years, the managing entity should review: a) how much the sectoral situation has changed i.e. if the benchmark is still relevant; and b) whether they are still eligible to get the extent of support they are receiving. As increased adoption overtime will remove the market barriers and shift current practice closer to NZEB.

b) Crediting period of individual activities under the programme

NZEBs built as part of the pilot will continue to reduce emissions compared to current practice for the length of the life of the housing asset. However, how many emissions they reduce compared to a new building that is not part of the pilot changes with developments in the sector and prevailing technologies. Further, because once it is built, NZEB housing will not need further financial support to continue reducing emissions, the critical threshold is to provide sufficient funding up front to enable the construction of the NZEB, and to ensure that the project implementer covers costs. The length of the crediting period can be linked to guidance / rules, modalities, and procedures under Article 6. The crediting baseline should however be periodically reviewed to account for sector and technological progression in the sector.

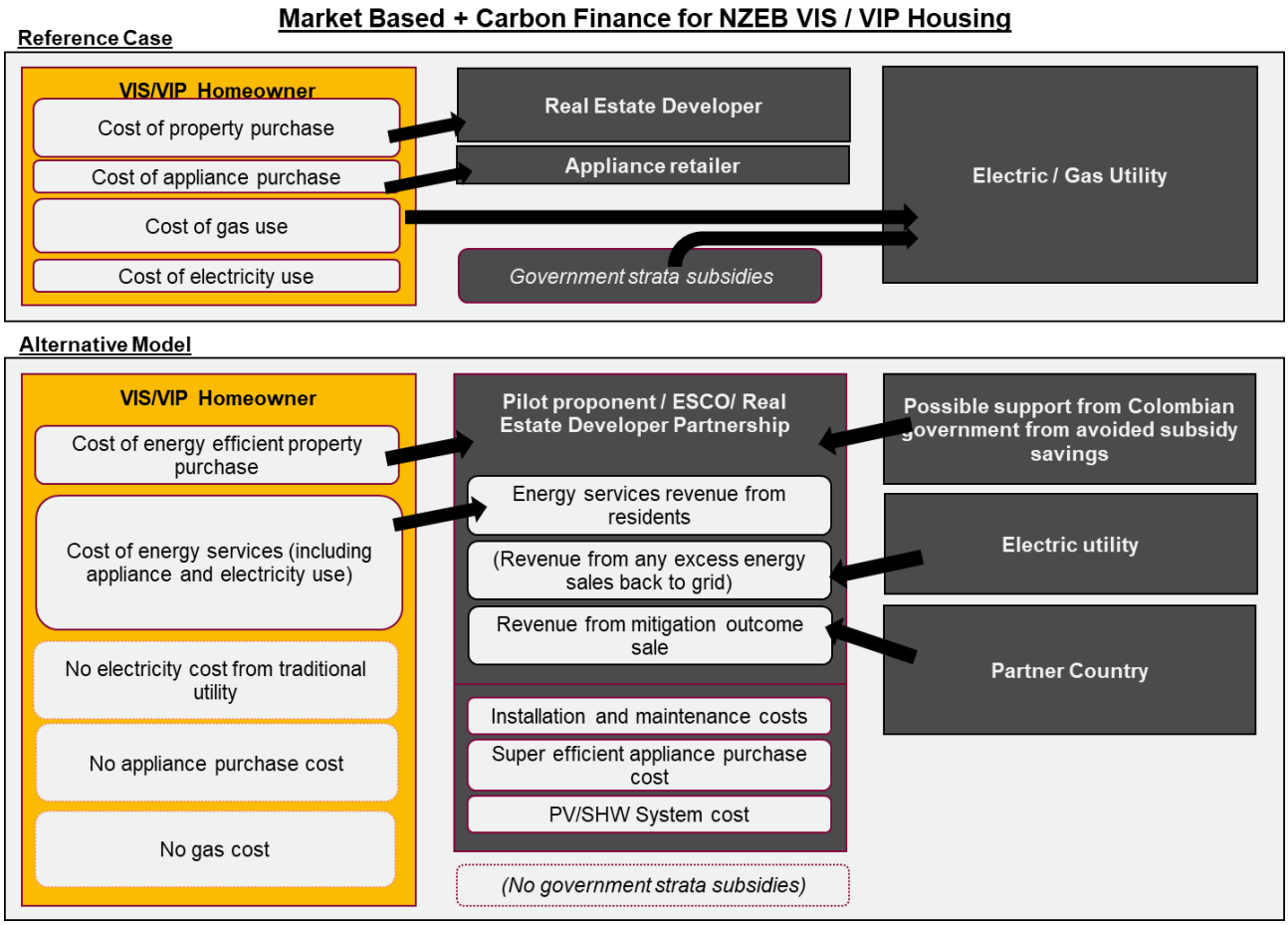
4.6.8 Funding of the Pilot

A cost assessment of the NZEB pilot for social housing in Colombia would take advantage of existing support for VIS / VIP housing in Colombia, with carbon finance to be sought for the marginal extra cost to make a VIS / VIP housing unit net-zero energy. Funding from the Colombian Non-Conventional Energy and Energy Management Fund (FENOGE), may be an option, depending on the current status of the fund and its future under the newly elected government.

Current cost estimates for a NZEB in comparison to a normal building complying with the requirements under Resolution 549 are as yet unclear. Although cost implications for Resolution 549, even for measures that were made voluntary for construction companies were expected to be lower than 2% of the total price of the house. Improvements are likely not feasible at current CER market prices.

However, a partner country interested in a bilateral agreement to promote NZEB as a pathway and demonstration project for the decarbonisation of social housing in the Colombian context, is sought to further finance investigation of cost assessment and feasibility studies. Such a pilot may be especially interesting for potential partner countries that place great emphasis on long-term transformation of sectors and sustainable development co-benefits such as poverty alleviation, improved health, clean energy access, job creation, and sustainable cities and communities.

Figure 8: Illustration of current vs. pilot funding models



Source: Author's own illustration.

For the renewable energy sources and high efficiency appliances installed on the building, an ESCO model may be conceivable where an ESCO would install and own the renewable energy equipment and potentially the appliances installed in the house (solar hot water heaters, photovoltaic panels, refrigerators, washing machines, microwaves, ovens, stovetops) and sell energy to the residents that own the housing units. Carbon finance could contribute to ESCO financing models to shorten amortisation periods for the ESCO and help save residents money compared to a normal VIS/VIP building where residents would pay local utilities for gas and electricity.

Several nuances will also need to be considered according to stakeholders. For instance, establishing eventual ownership of the equipment would be needed. This is an aspiration in residents of this housing segment and averts potential risks of intentional damage to equipment. In the design of the project, maintenance of the appliances and replacement would also be needed considering the limitations in paying capacity of the segment. More so, in the conceptual design, the analysis of cultural behaviours should be covered as moving from existing spaces brings along the risk of loss of social capital, which according to some stakeholders was a key consideration

in the Colombian context. There is also a culture of non-payment in these communities and legal framework may not support to facilitate payment (e.g. one cannot take away a house occupied by a family if it's the only property they possess).

A key feedback from stakeholders was to explore other non-typical "ESCO" companies could also play this role considering the nascent ESCO industry may not have the financial capital and risk appetite for such a pilot. Residential associations and/or utilities could play such roles, in the view of some stakeholders. Some residential associations have been owning communal appliances (e.g. in Cali). Similarly, utilities could have an agreement with the ESCO to reduce demand to share the risks. Some already are moving in that direction. [43].

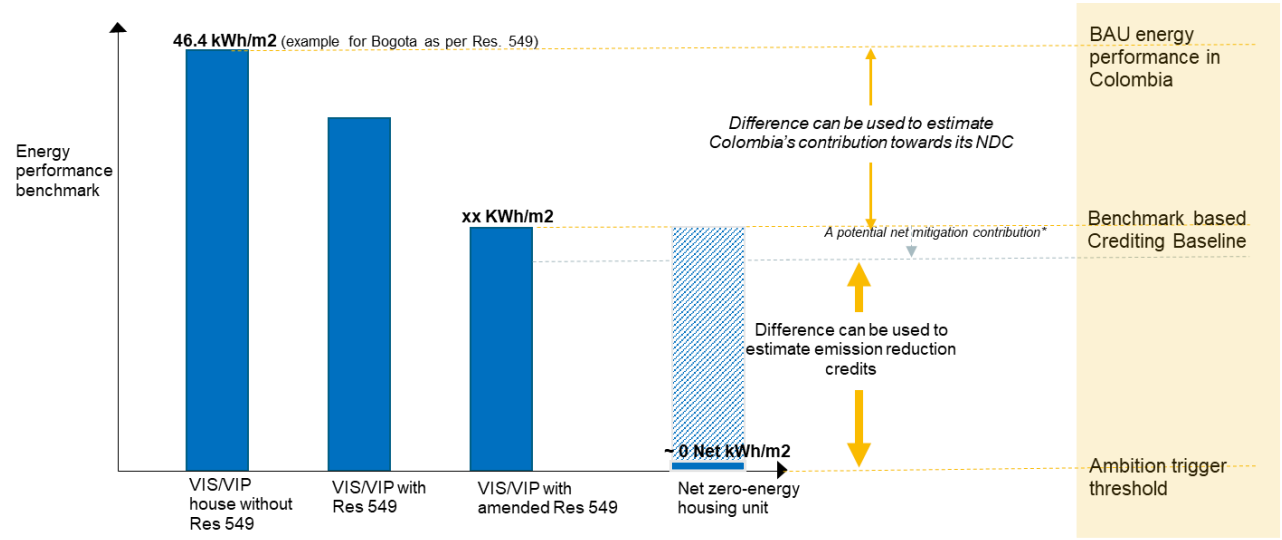
4.6.9 Approach for Estimation of Emission Reduction Credits (ITMO Estimation)

Crediting baseline benchmark. Under the CDM, crediting baselines were generally based on an estimate of business as usual in a given country. In the case of Colombia with a dynamic policy environment with a number of national, subnational, public and private actors active in promoting energy efficiency measures and future updates of policy/regulatory standards e.g. mandatory or voluntary MEPS. The crediting baseline would then need to be set to conservatively take account of any near-term evolution of building practices in the sector. In the minimum, the crediting threshold stringency should surpass any policy/regulatory standards (mandatory) and reflect building sector policies. Marginal improvement on energy efficiency would not be credited. Gap between VIS/VIP with Res 549 and the NZEB would require policy reform and improved effort from Colombia, including policy support and capacity building efforts. Aspects of the policy reform are discussed in section 5 and could be supported through a NAMA.

For the net-zero energy pilot approach, we propose setting crediting baseline benchmarks, based on a revised Resolution 549. This benchmark will go beyond common practice or BAU energy performance. The difference between the BAU common practice and Crediting baseline benchmark can be used to identify a contribution from the pilot towards Colombia's NDC. The benchmark can be further adjusted to deliver a 'net-mitigation contribution'. In this report, 'net mitigation' implies to earmark a portion of achieved reductions as an additional contribution to global mitigation. Our interpretation of 'net-mitigation' is embedded in Paris Agreement's Article 6.4 (d) which requires international cooperation to lead to an "overall mitigation in global emissions"(UNFCCC, 2015). While the Paris Agreement explicitly calls for this objective for Article 6.4 mechanism multiple parties call for similar provisions in Art. 6.2 (NewClimate Institute, 2018). A similar 'net-mitigation contribution' can be defined on the buyer side as well, for instance by cancelling a part of the purchased reductions. Once reductions are set aside as a 'net mitigation contribution' these can no longer be used by either Party towards their NDC (Kreibich, 2018; NewClimate Institute, 2018).

[43] One such company is Celsia, which owns, operates and leases PV panels to private companies: The following link leads to the internet: http://www.celsia.com/

Figure 9: Net Zero energy pilot energy use vs benchmark



Source: Author's own illustration.

As part of the Net-Zero energy pilot, an "***ambition trigger***" would be set so that participants in the pilot would have to reach net-zero energy status before receiving credits. The ambition trigger is set so as to demonstrate a path towards decarbonisation of the sector in line with the Paris Agreement. Although a building that represents a marginal improvement beyond the revised benchmark established by the measures required by a revised Resolution 549 would reduce emissions, any residual emissions would be locked in until a future retrofit of the building. The added "ambition trigger" provides incentive to build more efficiently is provided by the fact that credits are only issued when a project reaches NZEB status.

Mitigation Outcomes (MOs) would be generated by multiplying the difference between the crediting baseline benchmark measured by KWh/square meter and when NZEB status (ambition trigger threshold) is reached with size of the housing unit and an energy use emission factor (electricity and natural gas based) in tCO_2eq/KWh).

$$MO = \left|0 - \frac{Benchmark\ KWh}{sqMeter}\right| * Area * tCO2e/KWh$$

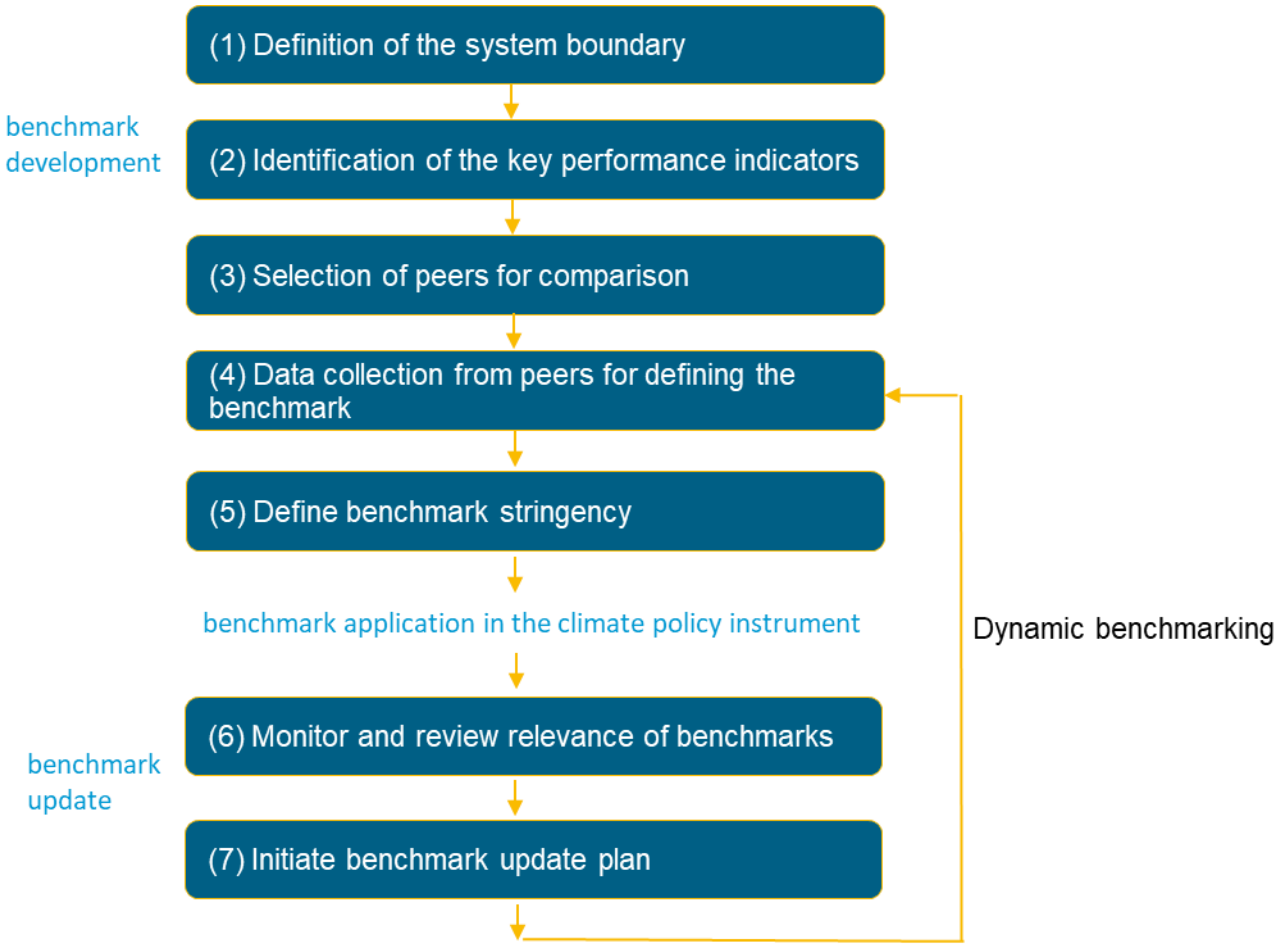
A key aspect of the pilot crediting is the establishment of a robust and ambitious benchmark.

4.6.9.1 Developing Benchmarks for the Pilot

The key technical steps in robust benchmark design for buildings are as follows in Figure 10. We discuss these generally and summarise their role in the context of developing a baseline crediting benchmark for a NZEB pilot. Although a baseline was established as part of the policy development process for Resolution 0549, sample sizes in some cases were fairly small, may have some data anomalies and the BEA programme for Bogota found it necessary to develop a new baseline for the Bogota programme itself. Depending on the city and the sample size to develop the baseline, it is probably best to update the baseline with new data in a particular target city.

1. Setting system boundaries
2. Selecting peers for comparison
3. Identifying a key performance indicator
4. Collecting data
5. Setting stringency
6. Monitor and review benchmarks and initiate benchmark update plan

Figure 10: Main steps in a benchmark development exercise



Source: Adapted from (Warnecke and Fekete, 2013)

Setting System Boundaries

Fundamental to benchmark development is the identification of activities that can be grouped together and compared to reasonably establish a benchmark. For assessing environmental performance, these include relevant emission sources which could include both operational and embodied emissions, and activities leading to these emissions e.g. typical building design features, energy efficiency of appliances and typical energy use. However, for the purposes of the pilot, we propose limiting the scope to operational emissions.

Operational emissions from a building include direct and indirect emissions. Emissions occurring by on-site combustion are considered as direct emissions. These include activities such as cooking, heating water on a cookstove and leakage of chlorofluorocarbons (CFCs) from household refrigerants and air conditioners. Refrigerants in Colombia are however addressed through a NAMA and the focus of the proposed Net Zero Energy Building pilot is emissions related to energy use. Beyond direct emissions, households are also indirectly responsible for emissions by using purchased electricity[44].

Selecting a Relevant Group for Comparison

[44] In areas with district heating or cooling, purchased energy could include heat or cold from a district heating/cooling system, however district heating does not exist in the Colombian context.

Selecting the right group of peers for comparison is critical in defining a benchmark that adequately represents a specific activity.

Two factors are typically considered when selecting comparable peers in the building sector:

Broad building groupings with marked difference in energy use such as residential and commercial buildings are grouped separately. Each broad group can be further broken down into subtypes, e.g. based on sizes, built-types (single party vs multi-party houses), and specific purposes (e.g. hospitals, schools, public buildings etc.).

Social housing based on its homogeneity in design and potentially energy use patterns as catering to a certain paying capacity of that income segment is a specific category in residential building sub-sector. In the case of social housing, the comparable economic activity is considered to be providing living space within a World Health Organization thermal comfort range of 18-24°C (Ormandy & Ezratty, 2012), as well as cooking, refrigeration, lighting and other normal electricity services for an average household size in VIS / VIP housing. However, further differentiation within social housing is not recommended. There are arguments for both differentiation and no differentiation based on bio-climatic zones. Differentiation makes sense if the energy required to maintain a normal comfort level of between 18-24°C varies widely between different climatic zones. However, differentiation adds more transaction costs for both administrators and regulated entities. It is recommended to start the pilot with one benchmark in one climactic zone where there is the expectation of a large increase in the need for social housing such as Bogota or Medellin. Average low temperatures at night in Bogota go down to 8°C while, but generally do not exceed 20°C throughout the year. In Contrast, average low temperatures in Medellin are around 17°C, but average high temperatures are around 27-28°C. Depending on the energy needed to heat in Bogota and Cool in Medellin, the benchmark for each may be comparable.

Hence, while it typical to set a benchmark based on these two elements, doing so for a pilot in Colombian social housing depends very much on how different energy consumption really would be to fulfil these conditions and what transaction costs it entails. These aspects should be kept in mind when designing the baseline crediting benchmarks for such a pilot.

Identifying a Key Performance Indicator

Identifying an appropriate indicator to compare the environmental performance of peers is a key step in benchmark development. For buildings, energy use intensity (EUI) of the building is a key performance indicator. EUI normalises the energy use of a building based on its size or other characteristics impacting performance e.g. occupants, used space etc. Energy use/unit area/year is commonly used in the context of residential buildings. 'Energy use' is typically measured in 'kWh' and the 'area' could be living space or total floor space (i.e. living space and storage space). Depending on the policy goal, the energy use benchmark can be converted into an emission benchmark as well.

Social housing is a typical segment of residential buildings. These are compact dwellings with standardised design. Further, a reasonably similar energy use can be expected due to limited paying capacities of the occupants. Colombian social housing has 3 lot sizes - single-family houses have a minimum lot size of 35 m^2, two-family houses a minimum lot size of 70 m^2, and multi-family houses a minimum lot size of 120 m^2 (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2004).

For a KWh/unit area indicator, floor space and living space may not be different in social housing due to their compact size. Another benchmark that can be considered in social housing is a KWh/housing unit or KWh/family unit. The former normalises energy use for a single housing unit while the latter normalises it to housing unit types (e.g. single-family house, multiple-family

house etc.). Warnecke and Fekete (2013, p.69) in their study on benchmarking in South African social housing sector recommend a kWh/housing unit benchmark due to the relative homogeneity of energy use in South African social housing sector. A KWh/housing unit (or family unit) may also be relevant for social housing. However, in our assessment a KWh/unit area benchmark is a reasonable starting point for such a pilot considering existing policies (i.e. resolution 0549) and activities (e.g. EDGE and BEA programme) also use similar metric.

Collecting Data

Data collection is a challenging step in developing building energy performance benchmarks, especially in countries where building design is not regulated or those with weak policy enforcement and monitoring.

Benchmark development requires collecting data on building stock energy use. In the US, for instance, the Energy Information Agency (EIA) administers regular residential energy consumption surveys (RECS[45]) to a nationally representative sample of housing units. Specially trained interviewers/ web or mail-based forms are used to collect energy characteristics on the housing unit, usage patterns, and household demographics. The survey results are used to compile energy use databases for the building sector, which are used in several energy efficiency programmes (e.g. the energy star program). Other ways to gather information include audits or through energy bills from utilities (Pé Rez-Lombard, Ortiz, Gonzá Lez, & Maestre, 2009). However, a lack of such datasets when beginning to develop benchmarks in the building sector until systematic energy performance databases are developed is a key challenge in many countries. In many EU countries, a lack of building energy databases and the difficulties in creating them through audits led to alternative approaches (Nikolaou, Kolokotsa, & Stavrakakis, 2011). One approach has been the use of models to simulate expected energy consumption in representative buildings. Models generate representative building datasets by running simulations for a range of constructional and operational parameters such as building use, building size, construction material, climatic conditions etc (Nikolaou et al., 2011). Simulation tools can be used to generate key energy performance indicators for the baseline as well as define expected performance improvement benchmarks and potential measures to reach them. Minimum constructional/energy efficiency standards prescribed by policies are considered to build a baseline case if they are robust enough.

The Mexican Housing NAMA for new buildings provides a relevant example as a regional approach (details in section 5). For the NAMA design, simulation tools from Germany's Passiv Haus Institute were adapted to the Mexican context (software DEEVi) and used to model 3 baseline building categories (isolated housing unit, row housing unit and vertical housing unit) existing in the Mexican market for 7 bioclimatic zones based on local data on construction systems, building traditions, materials as well as equipment available on the local market and energy production (Conavi, 2011). The resulting simulation produced three energy performance standards/benchmarks that go beyond the simulated baseline energy consumption benchmark. The key performance indicator was kWh/m^2. Note that total emission reductions were also calculated in the NAMA for MRV purposes.

Simulation based approaches can offer detailed information but require skilled manpower and can be expensive and time-consuming (Pé Rez-Lombard et al., 2009). Furthermore, a simulations-based approach doesn't circumvent the data collection step entirely. Once set and in use, the simulated standards need to be crosschecked with collected data, as actual energy consumption of buildings can deviate from simulated figures and change over time. In the case of the

[45] For more information see: The following link leads to the internet: https://www.eia.gov/consumption/residential/about.php

Mexican NAMA, an ex-post monitoring of some houses demonstrated that real life energy consumption fits well to the design energy demand calculated by DEEVi. Baseline surveys need to be conducted on a regular basis to maintain relevance of the benchmark.

Colombian stakeholders have experienced challenges with survey-based data collection while collecting baseline energy consumption data for setting energy performance targets under resolution 0549's Sustainable Construction Guide. During consultations for this project, many stakeholders stated issues with the baseline survey. These included small and/or lack of representativeness of the sample and lack of any historical data to cross-check, limited capacities, and systems in place to administer the process and generally monitor changes in the sector (e.g. market data on appliance energy efficiency). While some building design related issues are less relevant for social housing, other issues would remain. Managing entities for the pilot will have to be mindful of these challenges if they develop a benchmark to understand the current situation. A modelling-based approach could be explored to simulate the beyond BAU crediting baseline benchmark. To do so, the managing entity of the programme will have to collect data on modelling input variables such as construction design, practices and materials used, energy efficiency of appliances availability in the market etc. If in-country technical capacities to develop such modelling approach are limited, international partners supporting such ambitious Article 6 activities may provide upfront technical assistance to develop the required modelling frameworks. The capacities built in the process can help Colombian policy making in extending such an approach to other building segments as well.

Review Benchmarks and Initiate Benchmark Update Plan (Dynamic Benchmarking)

While the net-zero benchmark is absolute, the crediting baseline benchmark needs to be reviewed and updated regularly to ensure that it continues to be representative of the sector. This requires regular monitoring the energy performance of non-pilot housing regularly (as previously discussed); deciding when to review benchmarks (for example in the Colombian case; the benchmark could be reviewed in parallel to the review of the mandatory measures under resolution 0549); how to review benchmarks (for example conducting sampling surveys to monitor how real life consumption has change or through energy use data from electricity bills); what triggers and update (for example an update of the sustainable building guide), and a check for market developments such as appliance energy efficiency. While buildings built at a certain time would continue to use the same benchmark for the length of their crediting period, new buildings entering the pilot would then have to use the updated benchmark.

5 Policy Reform and Ambition Raising to Drive De-carbonisation in the Building Sector

In the previous sections, we discussed the potential use of a market-based approach to develop experiences in net-zero energy buildings in the social housing segment. However, achieving the temperature goals of the Paris Agreement requires comprehensive and transformational action in the entire sector. A Paris compatible transformational mitigation translates to a complete de-carbonisation of the sector. This requires mainstreaming buildings that consume zero or near-zero energy in the housing segment.

The proposed pilot in the previous chapter may help for buildings within its scope and have positive spill over effects through technology transfer, increased technology penetration, experience with practices etc., however considering the challenging social, economic, financial and market barriers discussed in section 3, a single policy instrument will very likely be insufficient towards a net-zero energy target for all buildings or even all new buildings. Rather, a comprehensive policy package is needed to address barriers and mobilise different actors. Such a policy package needs to include complementary policies that support and reinforce each other. A policy package should: concentrate on eliminating direct emissions from buildings; significantly reduce energy demand thereby reducing indirect emissions; and promote onsite renewable energy generation. “New buildings” are an important starting point for policy interventions not only to avoid lock-in of emissions in the future built stock. However, policy action in new buildings must also be complimented with ambitious renovation of existing building stock.

In this section, we discuss not only the social housing VIS/VIP sector but analyse the role of comprehensive policy packages for transformative mitigation in all new buildings. We first elaborate the design of a good practice policy tool-box and specific policies such a package could entail (section 5.1). In doing so, we draw from literature on policy practices and the project team’s own experience from building energy efficiency interventions in Germany and Mexico. Using this analytical lens, we next discuss specific gaps in the current policy landscape in Colombia (section 5.2). Lastly, we identify concrete recommendations for a comprehensive policy tool-box which orients new housing infrastructure development towards zero-energy consumption (section 5.3).

5.1 Policy Pathway Setting – Review of Global Practices

As discussed in section 3, Colombia is making concrete efforts towards encouraging energy efficiency in the housing sector. There are a number of international examples that however may offer meaningful takeaways for policy makers considering further reforms and next steps in Colombia. Furthermore, two detailed country perspectives are discussed to identify key lessons – Mexico’s NAMA on New Housing and German’s policy approach for building energy efficiency. In the next paragraphs, we summarise these to define what good practice policy tool-boxes entail.

5.1.1 Good Practice Policy Tool-Box for the Housing Sector

A transformative policy package targeting net-zero energy use in ‘new buildings’ requires policies targeting both indirect and direct emissions in individual building. For the former, a two-pronged approach is necessary. First, to define policies that mainstream highly efficient building design and efficient components. Second, to create an enabling environment for own green power generation. Lastly, policy efforts are needed to eliminate direct emissions from buildings. Different complementary policies support each objective.

5.1.1.1 Define a Policy Pathway for Accelerating Improvements in Building Energy Efficiency

Regulatory policies therefore play a critical role in initiating energy efficiency in the building sector. A clear policy pathway is needed to mainstream ultra-low energy building design and super-efficient appliances over time. This requires a constant but dynamic policy approach that sets ambitious mandatory requirements for energy efficiency improvement, a clear direction to progressively ratchet-up regulations; and that sets incentives for action beyond the mandatory requirements to prepare the market for future ratcheting-up of regulatory targets; and that steers the market towards ultra-low energy buildings. Regulatory policies are needed to more or less standardise energy use in specific building types in the sector. Once this benchmarking is done, the regulatory cover can be progressively strengthened to reduce energy use towards the zero or near-zero energy benchmark.

Mandatory building energy performance standards (MBEPS) are the centrepiece of regulatory policies in the building sector (bigEE, 2013; GBPN, 2014; Laustsen, 2008; Lucon et al., 2014). Minimum energy performance requirements for new buildings can be incorporated in existing building codes or developed as standalone mandatory 'building energy codes. MBEPS typically cover minimum standards for overall energy performance of a building (e.g. energy use per unit area). This energy performance calculation typically includes elements of the building envelope such as architectural design, natural lighting etc. and some appliances (internal heating/cooling, hot water, lighting etc). The exact specifications of the calculation are however country-specific. The value of MBES as a policy tool is reflected in the fact that over 30 countries referenced building energy codes as part of their Nationally Determined Contributions (NDCs) under the Paris Agreement (Evans, Roshchanka, & Graham, 2017).

Building energy codes are increasingly moving away from prescriptive to performance or outcome-based design. Prescriptive energy codes, as the name suggests, prescribes the approach builders should take in order to achieve the mandated energy efficiency targets. While prescriptive codes have the advantage of being structured, simple and easy to verify; over stringent prescription of measures can be taken to comply has been seen as a barrier to flexibility, innovation and cost-optimisation for the market players. Furthermore, prescriptive codes need regular revision to catch-up with rapid market movements in energy efficiency and renewable energy. Keeping up with the market also entails substantive administrative baggage for regulators.

Many countries with experience in building energy efficiency policies have moved away from a prescriptive approach of defining "what to do to reach a goal" in to a performance-based approach, where the regulator defines only the objectives and performance metrics to reach it (GBPN, 2014; Huelman, 2012). Performance-based codes give developers flexibility to choose appropriate ways to ensure compliance. The EU, for instance, progressively shifted to a performance-based approach from a prescriptive one in the 2002 Energy Performance of Buildings Directive (EPBD) (Allouhi et al., 2015). Performance-based approaches are also a commonly discussed in the USA. We also refer to these in the description on Germany and Mexico in the next pages.

Effective code implementation is one of the biggest challenges faced by policy makers across the globe. Evans et al. (2017) and GBPN (2013) discuss code implementation practices and good practice examples in select countries. Four practices are relevant when discussing code implementation: a) Compliance checks or Inspections. Compliance checks are part of the code enforcement procedures, where designated personnel check compliance with the code at different points of time during and after building construction. Inspection frequency and occurrence (during construction, on finalisation of construction, post-occupancy) is an important element to ensure compliance. A key good practice is to have post-occupancy checks. However, very few countries have those. GBPN (2013) in their review of good practice does, score Sweden the highest in

building energy policy implementation because they have post occupancy energy verification procedures. b) Incentives and penalties for code implementation. Practices vary from monetary incentives to comply (e.g. subsidised loans, tax credits etc.) to penalties such as suspension of licenses (Table 14: Examples of incentives and penalties for building energy code compliance. c) Ease of compliance. Giving multiple ways to comply with the regulatory requirements helps in increasing compliance. An interesting suggestion comes from the US, where some states allow and accept the use of some voluntary labels to provide flexible compliance pathways such as the HRES index or NZEB index for more ambitious housing developers to go to net-zero. d) code compliance evaluation. Compliance evaluation includes a policy-level evaluation of the overall compliance rates and is aimed at identifying major issues in code compliance and prioritise future action (Yu et al., 2014). Compliance can be checked using statistical software, surveys, consultations etc.

Table 14: Examples of incentives and penalties for building energy code compliance

Penalties/Incentives	Country examples
Denying construction permits	Australia, Canada, China, Germany, South Africa, Singapore, USA
Suspension or loss of license	Australia, Canada, China, Germany, New Zealand, Singapore, UK, USA
Programmes to go beyond regulatory requirements (e.g. benchmarking, awards, subsidised loans, tax credits)	Australia, Germany, Canada, France, Italy, Japan, New Zealand, Spain, USA, Singapore
Permission to build a larger building than zoning otherwise allows, if construction exceeds code	China, South Korea, USA

Source: (Evans et al. 2017) based on GBPN

MBEPS are complemented with policies that encourage going beyond the regulatory minimum. While energy codes set the minimum performance, they may fall short of providing incentives for those wanting to go beyond the regulations. Housing labels and certificates are commonly used policy instruments to do so (Allouhi et al., 2015). By recognising efforts that go beyond the MEBPS, labels and certifications play a bridging role in preparing markets for more stringent future regulations (e.g. stricter MEBPS). France provides a relevant good practice example in this context. French energy efficiency standards are among the best globally (GBPN 2014). The current standard - RT2012 was adopted in 2013, replacing its lesser stringent predecessor. RT2012 adopted the maximum energy consumption requirements which were previously part of the quality certification - BBC (Bâtiment Basse Consommation): a quality seal for near-zero energy buildings. The quality certifications that go beyond the RT2012 standard are set at two levels: HPE (Haute Performance Energétique) and THPE (Très Haute Performance Energétique). The former requires a reduction of 10% on RT2012, while the latter a reduction of 20%. RT2012 will be further strengthened to RT2020 to require all buildings to be energy positive, i.e. generate more energy than they consume (GBPN, 2018). Another relevant policy experience comes from the US states in using 'stretch codes' (new buildings institute, 2018). A "stretch code" is essentially an additional energy performance improvement target on top of the base energy code. It is defined to recognise efforts of ambitious actors and drive additional improvements in the building sector. The US state of Massachusetts adopted its first (voluntary) stretch code in 2009. They provide additional support to cities that comply with the stretch code, e.g. through utility rebates and loan programmes for developers, and state incentives for renewable energy. Those who comply are branded as 'green communities.

MBEPS often feed-into net-zero energy targets. For instance, the EU's 2010 EPBD regulations requires member states to set standards for energy efficiency in new buildings based on energy performance of the building, supporting the target to make all new buildings nearly zero-energy by the end of 2020 (European Parliament, 2010a). The MBEPS requirements in many European countries are now planned towards the EPBD's target. For Paris compatibility, it is pragmatic for policy makers to align and progressively strengthen MBEPS towards a near/net-zero energy consumption buildings. Table 15 provides examples of policies with examples of few countries with net-zero energy targets.

Table 15: Policies for low-carbon buildings installation in selected countries

Country	Policy measure(s)	Description
EU	Energy Performance of Buildings Directive (2010) [1)]	All new buildings to be nearly zero energy by 2020. The Energy Performance of Buildings Directive 2010/31/EU (EPBD), Article 2, defines a near-zero energy buildings as follows: "…nearly zero-energy building' means a building that has a very high energy performance…The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby…"
Japan	Basic Energy Plan (2014) [2)] Zero Energy House/ Building Roadmap (2015) [3)]	All new buildings to be on average net zero energy in primary energy terms by 2030
California (USA)	Building Efficiency Standards [4)]	All new residential buildings to be zero net energy by 2020

Source: 1) European Parliament (European Parliament, 2010a), 2) METI (METI, 2014), 3) METI (2015a, 2015b), 4) California Energy Commission (California Energy Commission, 2015b, 2015a).

Improving energy efficiency of household use appliances is equally important to bring down the energy consumption of a house. Appliance Minimum Energy Performance Standards (MEPS) and labelling are commonly used instruments for this. MEPS defines the mandatory minimum energy performance expected in appliances, while labels provide information on energy performance as a description and/or a rating to compare products and inform purchasing decisions. MEPS are mandatory, while labelling can be mandatory or voluntary. Various countries have experimented with loan, rebates for and replacement schemes as incentive to get consumers to increase energy efficiency with new appliances. De la Rue du Can et al (2014) find that such programmes function best when they target highly efficient appliances that have a low market share (De La Rue Du Can et al. 2014a).

Policy makers should further define workable incentive structures. Schemes for demonstrating zero-energy buildings and providing financial incentives such as subsidised loans and tax rebates will support market introduction of zero-energy concepts.

Use of information policies such as Energy Performance Certificates (EPCs). The most common barriers that limit uptake of even rather simple energy efficiency measures is the information gap among home owners and tenants on energy efficiency related information of the house they purchase or rent. Energy Performance Certificates (EPCs) have proven useful in many European

countries to inform prospective owners and tenants about the energy performance of buildings. Many EU countries have experimented with EPCs by adding more user-friendly features such as providing the potential cost saving possible by adopting identified energy efficiency measures (e.g. UK) (European Commission, 2016, pp. 14–15). Some, such as Portugal and Ireland use such EPC datasets to verify the effectiveness of existing schemes and design future schemes (European Commission, 2016, pp. 14–15).

5.1.1.2 Create Incentives and, in time, Mandates for On-Site Renewables Deployment and Grid Integration

Policies that reduce energy consumption in buildings are not enough to move the sector towards net zero energy consumption and need to be supported by policies that substitute traditional fossil fuels for power and heating needs of a house. These include policies providing incentives for renewable energy generation in buildings (e.g. California's upcoming 'solar ready' rooftops policy), providing incentives for uptake of solar PV (e.g. net metering policy46 in the US or Germany's feed-in tariffs) and solar water heating as well as supporting innovation in storage solutions (e.g. tax credits). It is common to align regulatory or incentive based renewable energy policies with energy efficiency policies. Regulation providing private energy consumers in Colombia with the ability to sell electricity back to the grid came into effect in March 2018.

5.1.1.3 Eliminating Direct Emissions from Buildings

Onsite fossil fuel burning for cooking and heating (space and water) are significant energy end-uses in residential buildings (Lucon et al., 2014, pp. 678–679). Along with refrigerant leakage from household appliances (refrigerators and air conditioning), these are important sources of direct emissions in residential buildings. Inefficient cooking practices such as traditional cookstoves, open hearths using non-sustainable biomass is another major emitter in many rural (and urban) areas.

For reducing thermal energy use, solar thermal installations on houses and low-emissions cooking energy supply (switch from gas to electric) related policies must be made part of net-zero energy policy tool-box. Similar to energy use reduction in buildings, countries are now beginning to explore options to eliminate direct emissions. For instance, the Netherlands, which has domestic natural gas reserves and has extensive use of the gas grid for cooking and heating, set a target to eliminate gas as a source of heating and cooking from all homes by 2050. Residential heating contributes to some 10% of Dutch GHG emissions (energypost.eu, 2017). Local governments in California, including Palo Alto and Marin County have started to take regulatory action to electrify new buildings and phase out natural gas use to reduce direct emissions from buildings (Gerdes, 2018).

5.1.2 Regional Experience: Mexican NAMA for New Housing

Mexico too, has had experience in promoting efficient energy use both in housing in general, as well as in specifically social housing. The Mexican approach may hold lessons that are also relevant for Colombia.

Starting in 2012, the Mexico developed a NAMA to reduce GHG-emissions from new and existing social housing. It builds upon prior programmes to enhance energy efficiency in the building sector, which is responsible for about one third of the total energy consumption of Mexico (IKI Alliance, 2018). With an annual construction rate of approximately 600,000 new housing units, the

[46] Net metering allows home owners to feed surplus power to the grid as a credit. In the month's end, the home owner pays the difference between the energy generated and the energy consumed by the house over the billing period. In some places, a monetary compensation is provided if the net withdrawal from the grid is negative.

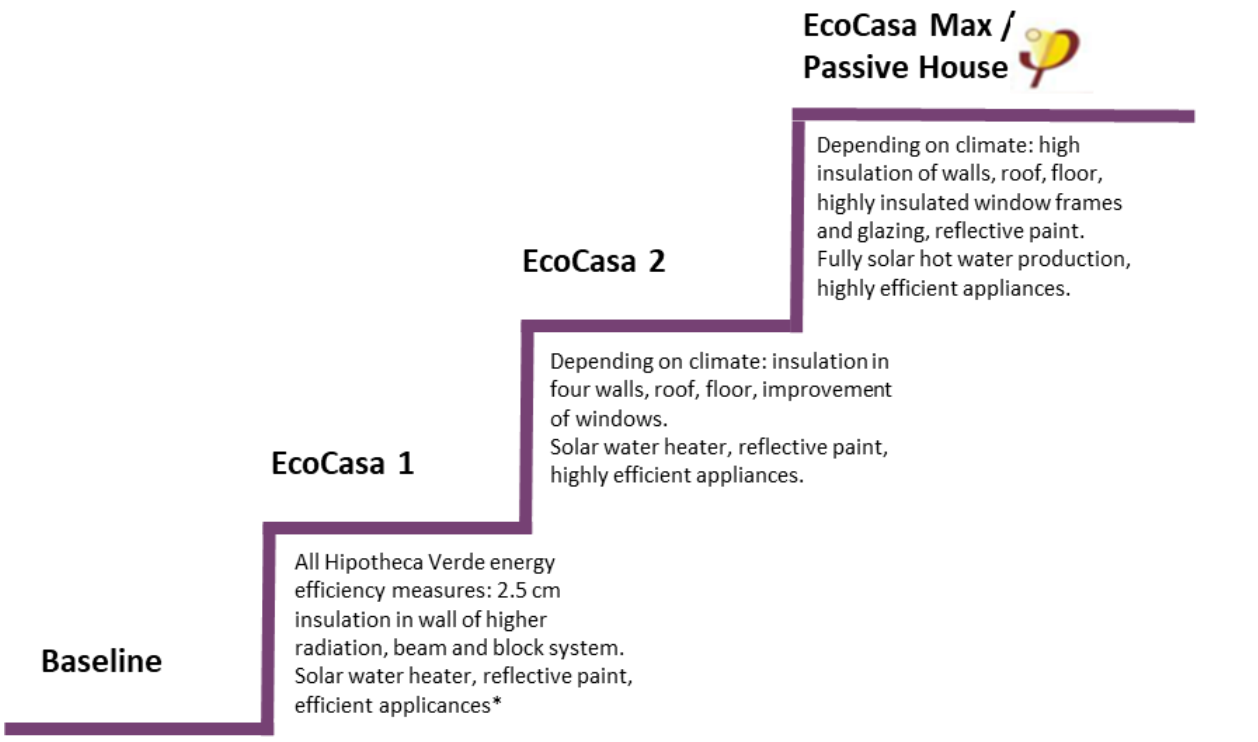
government identified significant mitigation potential in the sector. When deciding to develop this NAMA, the economic, environmental and social co-benefits played an important role. GIZ, KfW and IDB provided support in the development and implementation of the NAMA.

The housing NAMA built upon the existing 'Hipoteca Verde', a subsidy for eco-friendly houses. To receive this subsidy, developers need to include eco-technologies in their houses. Each potential technology is included in a list, given a certain value (say points) and if a minimum value is achieved by using a set of technologies, the house is eligible for the subsidy. Measures not included in the list cannot be used to comply with the requirements.

The NAMA however used a 'whole-house' approach: a 'whole house' approach packages individual mitigation measures in a building such as on lighting, heating, insulation etc. in a single assessment method. Assessing the whole house instead of individual technologies captures the interlinkages between different measures and can lead to higher savings and/or lower costs. The approach also greatly reduces administrative burden: a prescriptive list needs to be reviewed regularly to capture new technologies and other measures. To qualify under the NAMA, a house needs to have an absolute energy demand below a benchmark/threshold (MBEPS). The benchmarks depend on the region, housing type (i.e. individual house, town house, multi-unit house) and three different efficiency levels. The lowest level is oriented at the potential savings of the Hipoteca Verde, the highest level supports net zero energy houses. In addition, requirements for water saving are part of the NAMA as well. The NAMA focuses on new houses in the social housing sector.

A second NAMA looking at retrofitting existing building stock with a focus on selected appliances was developed in parallel.

Figure 11: Graduated benchmarks towards net zero energy under the Mexican Housing NAMA



*In the current Hipotheca Verde scheme, only some measures can be chosen by the project developers for additional credit. For the NAMA, all the energy efficiency measures available for Hipotheca Verde were chosen as an optimidation of the programme.

Source: (SEMARNAT, 2012)

As the housing NAMA focussed on social housing, one constraint was, that the costs for the end-user had to be comparable to the cost of average social housing to qualify for any subsidies. In other words, developers had to take up any additional costs for building these houses on their own.[47] The main incentives for developers to participate in the NAMA are:

- **Preferential disbursement of existing subsidies:** In mid-2015 CONAVI decided to prioritise new building projects in the allocation of its federal housing subsidies, which apply basic NAMA standards. Since CONAVI adopted the new policy, the market penetration of the NAMA increased from initially 4.5% in 2015 to approximately 22% by the end of 2017. In December 2017, the Mexican Government expressed the intention to adopt the New Housing NAMA as public policy aligning the various national social housing programmes to the technical criteria of the original housing NAMA. On March 7th 2018, the Mexican government officially adopted NAMA reduction targets as part of the award criteria for housing subsidies, staggered according to climate zones and NAMA mitigation ambition.

- **Financial cooperation:** Some Sisevive-ecocasas received support through financial cooperation. This support includes bridge-loans, additional subsidies and bank guarantees. Bridge loans at preferential rates are used to cover the incremental costs of the eco-technologies for the period until the housing unit is sold. Developers need to pre-finance their projects and only receive any social housing subsidies when a unit is sold to an eligible buyer. Bank guarantees were used to support the introduction of technologies uncommon in Mexico, to support market adoption. Due to lack of experience with these technologies and their associated operating costs, savings banks did not have the data to evaluate them. With the international guarantees the risk for the bank was minimised, enabling them to finance these measures.

In addition to these direct measures, a whole set of supporting activities was developed and implemented to improve the uptake of the Sisevive-ecocasas:

- **Tools:** A total of three online tools support developers in the design and evaluation of their houses. The first tool, DEEVi, calculates the design energy demand for heating/cooling, warm water, lighting and some household appliances based on the physical building properties as shown in the architectural plans (size, orientation, location, materials etc) and equipped appliances. The result of the DEEVi calculations is used by developers to show compliance with the Sisevive-ecocasa standard. To calibrate DEEVi, more than 30,000 houses were simulated. One result of the calibration was to divide the country in 7 climate zones, three more than originally planned. The second tool, SAAVi, calculates water consumption and is also used to demonstrate compliance. A third tool, HEEVi, is not directly linked to the NAMA and assesses the location of the building's social and environmental aspects. These include access to public services like schools and doctors and the access to public transport. The results of the three tools are included in a building label which prospective buyers can take into consideration before they decide to buy a housing unit. A simple labelling scheme between A (best level) and G (worst level) shows the overall assessment

[47] Depending on the building type and climate zone a 20% reduction can be achieved without additional costs.

combining the different evaluations. Such a tool could support auto-declaration on the way towards mandatory and verified compliance regimes.

- **Capacity development** for developers, architects and government employees.
- **Compliance is checked during construction** through on-site visits. An existing compliance regime for social housing was modified to include the Sisevive-ecocasa requirements. In practice this depends on the institution financing the building and only spot-checks are conducted.
- **Awareness raising campaigns and other information for the general public** were used to generate demand for Sisevive-ecocasas. Pilot projects funded by international donors demonstrated the feasibility of the approach and efficiency levels.

The first three years of the NAMA have shown that a reduction in energy demand of 20% compared to the previous building practice is feasible through existing technologies and practices, for which Mexico did not require additional funding. According to estimates by GIZ, the additional cost per house is approximately 400 EUR but actual costs depend strongly on the climate zone (CONAVI & GIZ, 2017). As explained above, incremental costs could not be passed through to the buyers. In other words, the expected cost savings for water and energy are not used to offset higher house prices. So far, developers either have to reduce their costs somewhere else or need to accept lower profitability. If higher efficiency levels become mandatory, more advanced technologies such as PV or heat recovery systems would be necessary Depending on the speed of technology penetration and costs, it is probable that some kind of additional support to developers would be necessary. However, scale and market penetration tend to drastically reduce prices and long-term support might not be necessary even for higher efficiency levels. As in Colombia, energy is heavily subsidised for low income houses in Mexico and the main economic beneficiary of the Sisevive-ecocasa programme is the federal government through avoided subsidies. Calculations have shown that the programme leads to net cost savings for the government: with the highest efficiency standards avoided subsidies could be as high as 40 USD/sqm and year whereas the additional investment needs are just 20 USD/sqm and year over the lifetime of a house (Feist, 2012). An ex-post monitoring of some houses demonstrated that real life energy consumption fits well to the design energy demand calculated by DEEVi. Large scale monitoring systems have proven to be too expensive or complicated to implement. The intention is to get access to the electricity consumption data from the electricity provider but so far, no agreement has been reached. The obligatory national housing registry is being updated to include information on the energy performance of all new houses. Compliance – as in Colombia - is also an issue because municipalities, who are responsible to enforce the requirements, lack resources, power and sometimes the necessary political buy-in. Implementation of a norm on energy efficient building, in force and obligatory since 2008, still remains an issue.

Key take-aways:

- The use of a tool such as DEEVis can play an important role in facilitating and supporting compliance with
- Moving from a prescriptive list of technologies to an efficiency standard leads to higher savings, reduces administrative burden and allows developers to quickly react to new technologies and approaches.

- Optimising existing practices and technologies can lead to substantial reductions in energy consumption; this can be achieved without further national or international support. Capacity development and the provision of tools might be necessary to enable stakeholders to comply with higher requirements.
- Energy subsidies greatly reduce the incentive for potential buyers to take energy efficiency into account putting other considerations such as location and size first. Consequently, typical houses in the market are less efficient than they could be. In such markets governments need to take an active role through regulation, incentives and/or other measures to drive the de-carbonisation in the sector. Often, this leads to net savings for public budget due to avoided subsidies.

5.1.3 International Experience: Energy-efficiency in the German Housing Sector

The German experience may also be instructive for Colombia. Energy consumption of new buildings in Germany has declined from 300 kWh/m2 by approx. 75% since 1980 (BMWi, 2014). To achieve this, the German government has developed a number of policies and measures targeting property owners, tenants and businesses. Crucial in achieving this reduction has been a combination of regulatory requirements, financial incentives as well as research & development projects.

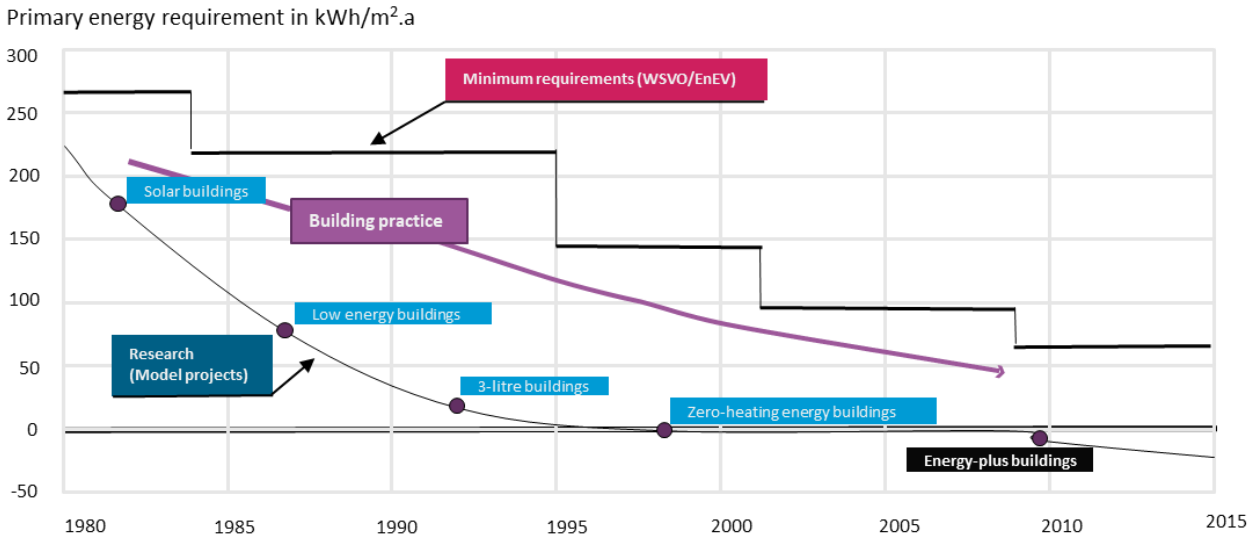
Energy efficiency requirements were first introduced in Germany in 1977. It provided maximum values for the thermal transmission of various building elements and the air-tightness of windows. These limits were gradually tightened and later on replaced with minimum requirements for energy demand per square meter. In parallel, pilot projects demonstrated the technological feasibility of much more ambitious buildings: the first houses with zero heating demand were built in the 1990s, while MBEPS only required an energy consumption of no more than 150 kWh/m2 (BMWi, 2014).

As in Colombia, the MBEPS are based on the physical design properties of the new buildings which are part of the building permit. Specialised engineering consultants calculate the theoretical energy demand based on these properties and standardised climate data and issue a certificate which is required for the building permit. In contrast to the Mexican example above, there is no differentiation between climate zones or different residential building types. The methodology for calculating the standardised energy demand is part of the regulatory framework and described in detail in various official norms. Verification is limited to the regular inspection upon completion of a construction project by the public administration; no verification or monitoring of actual energy consumption is required.

Financial incentives disbursed by the national development bank KfW help to bridge the gap between minimum requirements and the technologically feasible standards. The KfW disburses credits with preferential interest rates for buildings which meet more ambitious efficiency standards. House buyers can use the energy certificate to apply for the preferential loans through their own bank; the KfW does not disburse loans directly to end-users. Currently the KfW has a credit line for buildings designed to consume no more than 55% of the energy compared to the MBEPS, though these credit lines are only available for a maximum volume of 100,000 Euros – any additional required necessary finance must be found with conventional loans which generally come with higher interest rates. In addition to preferential interest rates, buyers get a 5% subsidy which they do not need to repay. For buildings that are designed to use

no more than 40% of the MBEPS this subsidy is 10%. The subsidy is 15% if, in addition to the higher efficiency standard, some advanced installations such as a solar PV system with a battery are also included.

Figure 12: Primary energy requirement in kWh/square meter area.



Source: (BMWi, 2014)

The success of this approach can be seen in Germany's learning curve with Passive houses, as seen by the progressive decrease in incremental cost of meeting the Passive House standard. The incremental costs for meeting the passive-house standard were over 300 EUR/m2 in the early 1990s.48 Passive houses do not require a separate heating system; the heat generated by appliances and the occupants is sufficient to cover the heating demand. These incremental costs have dropped to about 60 EUR/m2 within 20 years (bigEE, 2012; Schüwer, Klostermann, Moore, & Thomas, 2012). At this level the energy savings are sufficient to finance the additional costs at current energy prices and interest rates. Germany will be pushed towards higher ambitious targets by the EU, which has adopted a directive which requires that from 2021, all new private buildings should be nearly zero energy buildings (Directive 2010/31/EU).

Other important elements of the German energy efficiency strategy include various policies and measures addressing the existing building stock. Here the EU has also set targets calling for all existing stock to be progressively retrofitted so that all buildings are nearly zero energy by 2050 (Council of the European Union, 2017).

There are however a number of barriers to the renovation of existing building stock. In 2016 in Germany, only 46% of all households own the house/apartment they are living in; the majority of the population lives in rented apartments/houses (Statistisches Bundesamt (Destatis), 2016). As in most countries, there is a split incentive: heating is not included in the cost of rent and the landlords have little incentive to invest in energy efficiency: the cost of energy-efficient retrofitting of existing buildings need to be paid by the owner whereas the reduced energy bill only benefits the tenants. To overcome this barrier, separate credit lines for improving existing buildings have been introduced by the KfW. In addition, house owners are allowed to increase the rent by a certain percentage of the cost of the energy efficiency measures. Cost savings from reduced energy demand are expected to cover the additional rent.

[48] These compare with costs for conventional buildings ca.€1250 to ca. €1750 /m². Source: (bigEE, 2012; Schüwer, Klostermann, Moore, & Thomas, 2012).

Key take-aways.

- To achieve a transformation of the building sector, an integrated approach targeting all relevant actors is needed.
- Demonstration projects and incentives to build houses that go beyond current MBEPS can accelerate the improvement rate. Such projects help introduce new technologies into the market, bring down their costs and show the feasibility of higher standards.
- A strong compliance mechanism is necessary to ensure that MBEPS are adhered to. Independent certification of the energy performance which is linked to the building permit and on-site checks are one example to do so.

5.2 Policy Gaps for Transformative Mitigation in Colombian Housing Sector

There is potential to accelerate processes already set in motion to achieve sectoral transformation in Colombia's building sector by plugging in specific policy gaps. In the next paragraphs, we identify specific opportunities to improve Colombia's sectoral approach to mitigation. We base the assessment on discussions on existing activity in the sector and barriers with a range of stakeholders during two in-country missions and a broad-based comparison of existing policies against good practices identified in literature and own experience. We categorise these opportunities for improvement in the following.

5.2.1 Limitations of Existing Building Energy Efficiency Codes and Standards.

The primary policy instrument resembling an energy efficiency code or standard in Colombia in the sustainable construction guide (the guide thereafter). Colombia adopted the guide in 2015 (see section 3 for details). This was a significant step forward in standardising and managing energy use emissions from the buildings sector. However, two-years after its launch, the housing ministry has identified gaps regarding its design and effective implementation. The guide's provisions are planned for regular review every two years, with the first with the first review in 2018. Additional steps are necessary to move Colombia towards a zero-energy objective. We discuss both these under the design related issues in the sustainable construction guide, issues with monitoring and enforcement of the guide, challenges pertaining to future reviews, updates and a shift to a Paris compatible transformation.

5.2.1.1 Design Related Issues

In its current form, the sustainable construction guide has some clear limitations in the way energy performance targets are set and measures are defined to reach these targets.

Lack of a robust baseline for setting energy performance targets. The sustainable construction guide sets percentage reduction targets for energy consumption against baseline consumption for 7 different building types, including general housing and social housing (VIS/VIP) and 4 climatic zones. For each climate zone, one city was selected in which data collection took place. Housing sector's baseline consumption varies between 35 kWh/sqm (social housing, dry hot climates) and 50 kWh/sqm (general housing, hot and humid climates).

In some climatic zone-building type combinations, the sample used may not represent the building stock as a whole as sample sizes were small. In addition, data was collected only from the largest city in each climate zone. This data is likely to not be representative for the entire zone.

Data limitation is considered a key challenge for revising the baseline during the review of the standard scheduled in 2018.

A thinktank, CCCS, developed an independent baseline for Bogota using a larger sample of 58 projects from 22 companies (minimum 5 projects/ type of minimum 3 different companies) and arrived at a lower baseline than that proposed by the guide. Results of the BEA study for Bogota suggest that higher mandatory targets are possible for all housing categories, incl. social housing (which are voluntary in the guide). In addition, a 5-10% increase in targets is possible at an additional direct cost of 0.7%-1.6%.

Prescriptive nature of the guide: The requirements in the Sustainable Construction Guide can be equated to a prescriptive energy performance code, wherein energy consumption reduction targets are set, and a prescriptive list of measures is provided to market actors to reduce energy use. The sustainable construction guide provides a list of approx. 80 passive and active measures to achieve the targets. These are identified based on cost and scale of GHG impact. Passive energy efficiency measures cover aspects of the building envelope that are directly related to its energy efficiency. Active energy efficiency measures deal with equipment installed in the building in relation to air conditioning, lighting, heating/cooling and power. Several issues exist with the prescribed measures according to the interviewees:

- The actual impact of some measures is unclear (e.g. the very high reduction potential of using natural light is improbable). Details of measures are elaborated in section 3.
- Updating and maintaining the list of measures requires considerable resources and expertise within the ministry.
- Most importantly, prescriptive measures make the guide rigid and inflexible to adapt with market improvements. Some stakeholders, including the Housing Ministry (MinVivienda), were of the opinion that some measures prescribed in the guide are already obsolete as the market has moved further. For instance, some construction materials have changed, and some eco-technologies are now a standard in new houses (e.g. LED lights and efficient faucets). Solar PV is now much cheaper than the costs assumed in the guide. Furthermore, many stakeholders interpret Res. 0549 in way that developers are required to follow only the prescribed measures to reach targets[49].

The price cap on the price of social housing under government schemes Mi Casa Ya (up to US$30k for type II housing), Mi Casa Ya subsidy to interest rate (up to US$50,000) (Roch, 2017, p. 16), makes construction companies particularly sensitive to prescriptive measures, which have not kept up with technology trends in the market in the last two years of implementation. In some cases, measures in the guide are based on out of date pricing estimates, and construction companies often perceive costs to be higher than they are.

5.2.1.2 Monitoring and Enforcement Issues

The monitoring and enforcement of the guide has been quite challenging in the first two years after its roll-out. These issues link to the lack of a robust compliance mechanism and the uneven implementation and point to expertise gaps in the country.

Lack of a robust compliance mechanism. Enforcement challenges with building sector regulations are commonplace worldwide. However, a few compliance features are typical of global

[49] Based on discussions during the project workshop in March 2018.

good practices. These include: 1) post-occupancy verifications of compliance (e.g. in Sweden); 2) measurement-based monitoring of energy consumption, instead of calculations (e.g. Sweden); 3) strict penalties for non-compliance; 4) compliance statistics to keep track of effectiveness and update (e.g. New York). Resolution 0549 falls short in almost all these aspects.

In its current form, the sustainable construction guide doesn't have a formal compliance mechanism. Builders have to comply with the passive measures by submitting their architectural plans to get a certification of compliance at the time of permitting. The lack of documentation to support compliance is explicitly not a reason to deny an application. Compliance to active measures on the other hand is done only as a self-declaration, indicating compliance with the required savings percentages by applying the suggested measures.50

Local authorities are responsible for checking and enforcing the requirements at the building site. Little information exists on the national level to the extent to which this is effectively implemented but anecdotal evidence suggests that there are no compliance checks in many cases. The nature of penalties for non-compliance of the guide is also unclear and no verification of compliance is required by energy auditors. Companies are rarely financially penalised for not complying with the guide. In the absence of a defined MRV approach, the housing ministry has faced significant challenges in ascertaining the degree of compliance with the guide. Absence of compliance statistics makes the review and update process for the guide complicated and time-consuming.

Uneven implementation. Enforcement and implementation of the guide is left to municipal governments. Large cities like Bogota and Medellín tend to have much more capacity to implement regulations, with what is likely a large enforcement gap in regulations between these cities and their smaller counterparts. There are however a few ambitious mayors in small and mid-sized cities working with international programmes. Local governments have significant regulatory leverage in territorial planning, yet limited interactions between the housing ministry and sub-national governments regarding local planning and zoning (such as Plan de ordenamiento territorial or POTs) is a key enforcement gap. In our interviews, the limited communications between the national and sub-national level was also apparent. **The guide is not mandatory for social housing.** This along with the cap on house prices for social housing makes uptake limited. In some cases, though, local authorities have given preferential treatment to projects that voluntarily comply with the resolution.

Lack of expert capacity. Some stakeholders noted that while big construction companies have the capacity and experience to implement the guide, small companies often do not and there is a lack of experts available for hire/consultancy. A need for more and well-trained personnel certifiers and auditors is identified to develop an attitude towards measuring, monitoring and verifying energy performance improvement.

5.2.1.3 Future Reviews and Updates Towards a Paris-Compatible Transformation.

Revision cycles of the Sustainable Construction Guide are planned every two years with the first review scheduled for 2018. But the complexity of getting baseline information and understanding the changes in the baseline in the absence of clear scheme level MRV protocol which systematically collects data, makes the process complicated and costly for the regulators. A performance metric based on improvement against a baseline condition may not be worth the effort if reducing building energy performance to zero-energy is the end objective. Alternatives such as

[50] Based on housing ministry's presentation during the project workshop in March 2018.

an absolute standard on maximum energy consumption (KWh/m2) are likely to represent a robust alternative and is widely used in other countries.

The long-term **Sectoral Action Plan for mitigation in the housing sector (PAS)** of 2014 includes projections for the growth of emissions as well as emission reduction potentials in the housing sector up to 2040. It prioritises energy efficiency of appliances and infrastructure and construction related improvements to achieve the reduction potential. However, it lacks a clear action plan to realise the estimated reduction potential. Further, it was defined before Paris. Interviewees from DNP mentioned that revision of the PAS in line with Paris Agreement is not high on priority right now. The recently agreed CONPES on sustainable buildings makes a step further in defining a roadmap by setting the goal for all 'new buildings' to comply with certain "sustainability criteria" by 2030. The nature of these criteria and their compatibility with Paris goals is yet to be seen.

5.2.2 Challenges in Mainstreaming Appliance Energy Efficiency and Renewable Energy Technologies

Robust building codes and standards need to be complimented with policies towards uptake of energy efficient appliances. The penetration of energy efficient appliances is far below the price level that is cost efficient for energy consumers (Letschert, Bojda, Ke, & Mcneil, 2012; Mcneil, Letschert, & de la Rue du Can, 2008), which further adds to challenges in implementing energy efficiency measures. Colombia has both mandatory and voluntary appliance labelling in place since 2015 under the regulations RETIQ (Reglamento Técnico de Etiquetado). It covers domestic refrigeration, air conditioning, single- and three-phase motors, ballasts for fluorescent lighting, washing machines and cooking appliances. The efficiency levels for labels have not been upgraded since introduction, although domestic producers now have no problems to comply with levels A-C as per the regulator (UPME). No minimum energy performance standards (MEPS) exist for appliances, which means there is no regulatory approach to prohibit inefficient appliances from the market.

In a similar light, use of renewable energy technologies such as solar thermal and solar PV are also beginning to pick up in Colombia. The renewable energy law of 2014 (Law 1715/2014) outlines financial incentives for renewable energy investments, including income tax exemption, accelerated depreciation of assets, value-added-tax exemption and import duty exemption. However, the process of accessing these for private households is difficult as these are designed keeping companies in mind. There is an additional perception challenge in households. In March 2018, Colombian government passed a resolution (CREG 030/2018) to establish a net metering policy for households to sell excess energy to the grid. While the policy has set a framework in place for homeowners to feed power to the grid, local stakeholders see implementation of the policy still an uphill task.

The technical policy challenges are escalated by the limitations of financing for implementing green measures for households. Global experiences reflect the key role of energy service companies (ESCOs) as a vehicle for energy efficiency improvements in corporate as well as residential buildings. ESCOs provide efficiency services through mechanisms such as energy performance contracts that guarantee either energy or monetary savings to the client. The ESCO model is fairly new and experimental in Colombia, and enabling policy support (e.g. interest rates reduction, loan guarantees) for ESCO market development is slowly developing in the form of donor supported programmes discussed in section 3.

5.2.3 Addressing Direct Emissions from Heating and Cooking

While electricity consumption represents the majority of residential energy use, mitigation efforts to reduce power consumption only addresses indirect emissions of the sector. Among sources of direct emissions, cooking is key pollutant in Colombia's residential sector. Inefficient cooking practices using firewood predominate rural households (77% of energy consumption in rural households) (UPME, 2017). In urban centres, massive efforts in the past towards access to cooking gas have made natural gas the main energy source for cooking, with only a small proportion of LPG and electricity. This urban segment is an important one in the Colombian context as over three quarters of Colombian population is urban dwelling and close of 85% of this urban dwelling population falls in low-income housing strata (i.e. strata 1-2). Studies undertaken by UPME have pointed towards highly inefficient cooking equipment use in the lower income strata (Ministerio de Minas y Energía, 2016)). Further, low-income households also get a subsidy on cooking fuels.

PROURE's PAS -II (2017-2022) acknowledges the issue, but defines actions mostly for the rural sector, while initiatives for urban sector focus mostly on promoting good cooking practices and improved cooking equipment design (covered under RETIQ labelling) to reduce energy waste. Labelling was made mandatory for cooking appliances from April 2018 as per Resolution 40234 (Ministeria De Minas Y Energia, 2017). Looking at the high share of cooking in the sector's emissions, efficient use of gas for cooking won't suffice, cooking with gas produces direct onsite emissions and even the most efficient burners waste 30-60% of generated heat to the area around food, rather than cooking food directly, with most gas stoves at the worse end of the scale (Hager & Morawicki, 2013). Electrification eliminates direct emissions, and when combined with renewable electricity sources, is emission free. Further, energy efficiency measures such as a shift to induction stovetops that generate an electromagnetic field to generate heat within the metal of a pot or pan can reach efficiency levels up up to 90% (Sadhu et al., 2010).

5.3 Options for Policy-Based Transformative Mitigation in Colombia's Housing Sector

Based on the good practices and gaps discussed in previous paragraphs, we outline a number of recommendations for orienting the ongoing policy processes in Colombian building sector towards a net zero-energy goal. We begin the discussion with macro-level policies and narrow down to more granular interventions.

1. Recalibrate long-term sectoral strategies towards sectoral decarbonisation
2. Set an explicit net-zero energy target for "new buildings"
3. Define clear indicators to measure progress towards the net-zero energy target
4. Improve institutional capacities and mechanisms
5. Provide an enhanced financial support package

Recalibrate long-term sectoral strategies towards sectoral decarbonisation. Setting clear long-term plans towards eventual decarbonisation is a starting point for transformative action in any sector. Colombia already has a low-carbon roadmap in the building sector under the 2014 Low Carbon Development Strategies' Sectoral Action Plan for mitigation in the housing sector (Planes de Acción Sectorial – PAS). While the plan identifies energy efficiency of appliances; and infrastructure and construction related emissions as the areas of focus for future mitigation action and identifies some single measures to improve energy efficiency, it doesn't take a systemic perspective to regulate the sector's energy use profile.

Moving forwards, Colombia could recalibrate such sectoral planning towards a decarbonisation objective. Under the UNFCCC regime, such decarbonisation plans can be long-term strategies such as the mid-century low GHG emission development strategies, which countries are to be develop by 2020 as per decision 1/CP 21, paragraph 35 and in accordance with Article 4, paragraph 19, of the Paris Agreement. For buildings sector, a two-pronged approach for a) new buildings and b) renovation of existing built stock is needed. Apart from laying out a clear roadmap for low-carbon development, such an action plan can also help identify the mitigation activities that can happen domestically and where international support can help.

Set an explicit sectoral target for "new buildings". An explicit policy goal sends clear signals to the domestic markets and international investing community/donors on policy ambition. In the Colombian context, setting a target year for new buildings to achieve (near) zero-energy could be a natural starting point. The March 2018 CONPES for sustainable construction alludes to future sectoral target setting. This momentum can be harnessed to include a net-zero energy benchmark for all 'new buildings' to comply with by 2030.

Define clear indicators to measure progress towards the net-zero energy target. Choosing relevant indicators to monitor progress are necessary for policy effectiveness. Strengthening existing policies is a natural starting point for Colombia, which already has policy instruments that define benchmarks to systematically measure energy performance of buildings. Based on the preceding discussion on policy gaps, we recommend the following changes:

1. Increase robustness of the sustainable construction guide.

- Relax the prescriptive requirements in the guide, which limit flexibility for developers and is additional technical burden for the regulator. As discussed earlier, one could completely move away from any prescription or provide a flexible approach to use alternative measures/technologies/approaches to prove compliance.

- Simplify the energy performance targets in the sustainable construction guide. This could be done by using an absolute energy consumption-based target (KWh/m^2) and eliminating the current approach of percentage reduction over baseline. As discussed in section 4 and seen in the Mexican NAMA, simulation tools can be used to simulate energy consumption typical of specific building types to set the targets. Compliance can then be checked using simulation tools as well as through a sampling survey of some houses.

2. Facilitate enforcement and compliance with the guide.

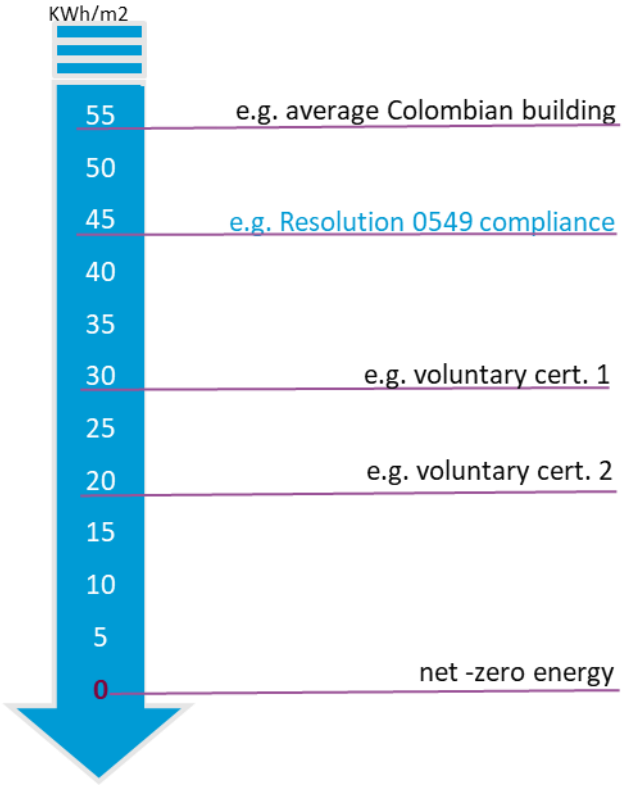
- The easiest gap to fill is to make the guide mandatory for all types of buildings.

- Furthermore, Colombian policymakers can assess the private labels/quality seals/ certifications currently operational in the Colombian market and recognise some as legitimate compliance pathways. The private certifications available in Colombia are the local standard CASA Colombia, IFC's EDGE, French standard HQE and LEED. Software developed under some of these (e.g. the EDGE tool) can be used by developers to show their compliance to the guide.

- Overcompliance to the guide can be rewarded, financially (e.g. better interest rates for those going beyond the guide) or recognised (e.g. through certifications). While recognition-based incentives might work better for commercial and high-segment residential buildings, financial incentives may increase interest in other market segments such as social housing.

3. **Define incentives to go beyond the guide.** Colombian policy makers could also experiment with setting additional standards similar to stretch codes in some US states discussed earlier to give recognition to early movers. Another way to recognise early movers is to develop quality labels that go beyond the sustainable buildings guide. This way the market can prepare itself for the next update. Colombia does not have any such information policies at the moment, although the regulator (UPME) is considering developing housing labels in future.
4. **Define an energy performance pathway leading to net-zero energy.** Choosing relevant indicators to monitor progress are necessary for policy effectiveness. To assess progress towards a net-zero energy benchmark (KWh/m^2), an option could be to develop a singular energy performance pathway towards the net-zero energy goal, as shown in Figure 13. This can be done by creating a single scale of energy performance benchmark-based on energy use intensity of buildings from current common practice (KWh/m^2) to net-zero energy (0 KWh/m^2). Once such a scale is created (say under a label), all existing regulations and voluntary labels, certifications etc. can fall on that scale. provides an illustration of such a scale. Such scale-based energy performance approaches have been explored in the US context as indexes (e.g. HRES index and ZEPI index). These can help contextualise individual performance to net-zero goal, provide multiple compliance pathways (i.e. a developer can use any approved certification to show compliance to the regulation) and recognise those going beyond regulatory requirements.

Figure 13: A potential energy performance benchmark scale aiming at net-zero energy



Source: Author's own illustration.

5. **Improve institutional capacities and mechanisms:** Our recommendations are two-fold: First, create a vertically integrated regulator by building concrete capacities in the national government to drive work in the sector and integrate role of municipalities in enforcing existing regulations. Particularly, it will be beneficial if municipalities integrate resolution 0549 mandates in their local land-use planning documents (POTs) and enforce them. Second,

collecting sectoral data on a regular basis, store it in appropriate formats and use for future policy review and improvement is a critical missing piece in Colombian energy efficiency policies for the sector. So, a key recommendation is towards developing infrastructure and capacities to develop an MRV infrastructure to check compliance as a first priority, as well as a system of sanctions for non-compliance in a second step. Here again, the municipalities can be the first point of compliance check overseeing the data collection, which can then be aggregated at the level of a national level regulator. Such a national regulator does not however currently exist and would require a further increased competency at the national level which would be associated with significant institutional change. To facilitate such compliance, an urgent need is to create an environment where more and more trained professionals (building inspectors, certifiers, modellers, ESCOs etc.) are needed. Creating skilled jobs is a positive spill-over of effective building regulations.

6. **Provide enhanced financial support package:** Setting the right financial incentives for private sector stakeholders to shift towards more energy efficiency and specifically towards a NZEB target is also important.

    a) **Financial resources from avoided energy subsidy payments**. Financial resources could be made available at the national level through the avoidance of subsidy payments at the Ministry of Finance.

    b) **Scaling up promotional loans for energy efficiency.** The main energy efficiency related financial incentives are promotional loan programmes for energy efficient housing of Bancolombia and Davivienda (see section 3). These provide a financial incentive to comply with the measures prescribed in the guide, and in some cases to go beyond, depending on the standard used to satisfy the bank's sustainability criteria. These programmes include promotional interest rates for both construction companies to comply with energy efficiency standards and house buyers to buy such properties. Certification of compliance is verified via an established labelling programme such as EDGE or LEED. These programmes started in 2017, so have not yet seen widespread adoption, but are growing steadily. These programmes could be scaled up, with a sliding scale of interest rates tied to the energy efficiency of buildings (see the German KfW and Mexico's hipoteca verde examples). Additional financing incentives to build net-zero energy buildings could also be considered.

    c) **Competitions and awards** are also an option to provide an incentive for construction companies and architectural firms to experiment with and implement energy efficient solutions to move towards NZEB building. Construction 21 International, for example, is an international platform of professionals active in the sustainable building sector that sponsors the Green Solutions Award for innovative sustainable buildings. Initially, funded by the European Union with chapters in France, Germany, Italy, Lithuania, Romania and Spain, the programme has expanded internationally and includes chapters in Asia, Latin America and Africa. Projects from anywhere in the world can apply. A similar local (or regional) competition could also spur innovation.

    d) **Targeted support programmes and utility-based energy efficiency.** Colombia, with the support of GIZ is currently implementing a support scheme for inefficient refrigerators (see section 3), but such approaches could also be expanded to other appliances. Sometimes, such programmes involve utilities. While energy efficiency is not normally in the interest of the utility, as more

efficient appliances means selling less electricity, several US states have implemented measures to decouple revenue and electricity sales and shareholder incentives to overachieve energy efficiency targets (De La Rue Du Can, Leventis, Phadke, & Gopal, 2014; Satchwell, Cappers, & Goldman, 2011; Schultz & Eto, 1990).

e) **Supporting ESCOs** Energy services companies that implement energy efficiency measures and on site renewable generation in exchange for a stream of future revenue financed out of energy cost savings also have a potential important role to play in driving further energy efficiency improvements in various kinds of buildings. Although currently more common in large commercial buildings with large demand for electricity and (hot water) heating, improving ESCO access to finance would help them expand activities to the residential sector, including home owner associations. A number of international finance efforts to facilitate their access to finance have been taken, however these could be expanded and scaled up. A key measure here is educating local finance institutions about the business model and providing longer term finance. Further, other fiscal measures such as reduced VAT or VAT exemptions could further promote the business model.

6 Options for a Comprehensive Approach Complemented by a Market Based NZEB Pilot

This study has explored different options for driving ambitious emission reductions in Colombia's building sector, with a focus on social housing. The feasibility of a standalone market mechanism compared to the need to move towards decarbonisation is explored in section 4; and the policy reforms needed for transformative mitigation are identified in section 5. Bringing together these assessments, a case can be made for looking into options that combine a comprehensive policy package with a market-based component that could (for a limited amount of time) demonstrate and incentivise ambitious innovative Net-Zero Energy Building (NZEB) practices in Colombia by supporting first movers, thereby spurring innovation. Since there are no existing examples for successful practical application of such an (innovative) market-compatible approach in either the social housing or the building sector in Colombia and even in the Latin America, this section must be understood in its conceptual nature rather than offering readily-implementable measures. Identified potential options need further development, refinement, and testing in the Colombian context.

The cost of energy subsidies the Colombian government provides to low-income residential consumers, the substantial costs social housing residents bear for energy use despite subsidisation, and the significant sustainable development co-benefits of improved building practices present a strong incentive for both Colombian households and the Colombian government to take measures towards increasing energy efficiency in housing. This, in many cases, is already underway but needs proper enforcement and regular update. More importantly, current sectoral policy processes specifically need reform to feed into a Paris compatible ambition i.e. to lead to deep decarbonisation of the sector. A process with this scale of ambition could greatly benefit from international technical support and climate finance.

Longer term sector-wide planning however has limited potential to provide shorter-term incentives for first movers to innovate and go beyond minimum requirements. NZEBs and their role in deep decarbonisation of the residential buildings sector is currently not under consideration in both the market, policy and development cooperation circles of Colombia. Pilot projects demonstrating NZEB could therefore fulfil an important niche in setting an ambitious precedent to introduce efficient, sustainable building practices in the sector and help Colombia leapfrog to a deep decarbonisation pathway in the sector. Moreover, it can provide an iterative process to inform policy orientation towards decarbonisation. Our analysis in section 4 has shown however that a purely market-based sectoral approach encounters a number of barriers in terms of environmental integrity. Further, it is specifically challenging to justify crediting marginal improvements under a post-Paris market-based approach given the difficulty of predicting future policy development in this dynamic sector. Such a mechanism may also find it hard to avoid effects of further incentive setting for future policies and hence identifying when to stop support. Therefore, it may not justify the high administrative and transaction costs market mechanisms typically have. Furthermore, crediting marginal improvements can impact Colombia's own prospects to ratchet up sectoral actions towards future NDCs. Article 6.1 itself sets an ambition raising imperative for international market cooperation. However, supporting demonstrable transformative change in the building sector such as promoting NZEB's can facilitate rather than obstruct higher ambition in the future.

Ambitious donors may therefore find the approach of facilitating introduction of NZEBs by nesting market-based pilots under a transformative policy support programme a lucrative option to gain experiences with post-Paris climate finance and carbon finance cooperation, while supporting sectoral transformation in Colombia. These are discussed in the next paragraphs.

6.1 Needs and Options for Transformative Policy Support Programme

In the housing sector, where expected emission reduction quantities are small and transaction costs high, the implementation of mitigation action requires support from targeted policies in order to lower serious barriers to investment. A comprehensive policy package may help to overcome the identified barriers and create incentives that promote direct investment into mitigation actions in the sector.

Barriers to emission reductions in the building sector are diverse and include the following:

- Knowledge: lack of understanding of energy efficiency options and opportunities across relevant stakeholders in the industry, government and wider population
- Institutional: lack of coordination between different involved ministries and absence of a central coordinating body within government
- Capacity: lack of expertise and resources to implement and enforce policies
- Information: lack of high quality and disaggregated data on energy consumption
- Market: limited commercialisation of energy efficiency equipment and services including ESCOs
- Financial: higher perceived upfront costs for some energy efficiency measures coupled with a lack of further incentives to go beyond minimum standards set out by the Sustainable Building Guide

International donors and technical assistance efforts have actively supported Colombian efforts to alleviate these barriers in the sector. According to the Climate Finance MRV Portal of the DNP, Colombia has received 438,027,706 USD in international climate finance for energy related efforts since 2011. This includes 23,078,233 USD for energy efficiency measures and 316,810,185 USD for the electricity generation and improving access to electricity (DNP, 2018). Specifically, the World Bank Group and the International Finance Corporation were particularly involved in the development of Resolution 549 and the measures included in the Sustainable Building Guide. The housing ministry however has limited implementation and enforcement capacity, which is generally left to local governments who in turn lack necessary insights. A clear pathway towards implementation of the resolution is only apparent in Bogota and to a certain extent in Medellin, although detailed information about awareness, implementation, and enforcement in other municipalities is lacking.

There is therefore an urgent need for further support for a comprehensive policy package that not only includes refinement of national level policies and building capacities for implementation and enforcement at all levels of governance, but most importantly serve a vision-setting role for a Paris compatible action pathway. Such support can take the form of a 'transformative sectoral programme' supported by ambitious donors (similar to the pre-Paris approach of NAMAs) to draw a roadmap to advance energy efficiency, electrification, and distributed generation of renewable electricity in a comprehensive manner towards the goal of sectoral decarbonisation. It should target all energy consumption of residential buildings including heating/cooling, cooking, electric appliances including refrigeration and hot water generation. Construction related emissions are excluded but could be considered in complementary programmes. The measures under such transformative policy support programme would build on existing and planned policies by the government of Colombia and ongoing initiatives and cater to the gaps in capacity, finance and general awareness.

Based on the detailed sectoral analysis in the preceding sections, we outline the key components of such a transformative programme. Such an approach could adapt and build on global and regional experiences discussed in section 5 and chart a pathway towards long-term sectoral transformation by maximising climate and development benefits. A programme of such a scale can take the shape of a multi-donor blended finance program, merging technical support components with climate finance and potentially a carbon finance nested within (described in the next section). In a way, this approach invokes complementarities between ‚transformative coalitions' of donor countries wanting to advance a particular mitigation technology with those wanting to build experiences on the ambition raising role of future carbon markets.

We outline three thematic components of the policy programme below:

Component 1: Technical support for development of energy use benchmarks and a systematic MRV(E) framework for net-zero energy social housing

Benchmarking done under resolution 549 to establish the baseline energy consumption (KWh/m^2) was the first concerted exercise in Colombia for a sector wide data collection. However, it has had several issues with sampling and data representativeness. The need for an improved regularly updated and tightened energy efficiency benchmarks for different categoreies of buildings through time that are recognised by local stakeholders, including the housing ministry. Considering local capacity limitations, technical support to facilitate development of a representative benchmark for social housing is a necessary starting point for supporting transformational change in Colombia. Such support could include, for instance, in baseline surveys and simulations for defining representative buildings as discussed in section 4. Simulation tools can also be used to generate benchmarks for expected performance improvement (what we refer as reformed resolution 549 in chapter 5) based on use of improved design characteristics and active measures then what is current practice (what we call the crediting baseline benchmark in section 4). Such a BAU benchmark and expected performance improvement benchmark can be used to determine a methodological approach to estimate the reductions achieved by individual housing units by achieving the NZEB status. The support should build local technical capacities directly, for instance as a competition among architectural students with technical support from international technical institutes.

Technical support can also facilitate development of an approach for monitoring, reporting, verification and enforcement framework for use of these benchmarks at the level of individual houses and as part of a policy implementation.

While we recommend social housing as the starting point for such a programme considering its developmental benefits and relative ease of execution due to regulatory control on this segment, it can be expanded to other housing types and existing building stock once adequate experience and capacities have been developed.

Component 2: Facilitate regulatory reform for enhanced uptake and effective implementation of net-zero energy approaches in housing development

Colombia has taken ambitious steps towards systematically addressing energy efficiency in the building sector. International support can support activities to incorporate a decarbonisation vision in existing policy processes. These could for instance include:

- facilitating inclusion of the benchmarks in amendments of the sustainable construction guide;
- following and aligning policy development on distributed generation, electrification, and appliance energy efficiency with a net-zero energy objective; and

- exploring the role of net-zero energy target setting for all new buildings in long-term planning. Colombia is already discussing a sectoral target setting for new buildings (for 2030) under the recently released CONPES. It could also include an analytical support element to develop a long-term trajectory for uptake of highly efficient buildings towards a net-zero target under for e.g. long-term mitigation strategies. Further research on linking this sectoral effort to NDC implementation, ambition raising, and sectoral targets could also be supported under such a programme.

In addition, Both the transformational policy approach and the complementary market-based NZEB pilot would require significant capacity building for policy makers on the national and local levels, as well as for architects, engineers, ESCOs, housing associations, and building inspectors and verifiers, which would represent an important benefit beyond potential GHG mitigation of the proposed measures. Such capacity building would not only contribute to Colombian implementation, but also facilitate future ambition raising.

Component 3: **Financial support**

International financial support could help finance upfront technical assistance under component 1 and facilitation under component 3. The transformative support programme will cater to address barriers to accurate and robust GHG quantification which will likely require financing that is not a focus of private climate finance channels, especially given that many of the measures included are prerequisites for transformation of the sector but cannot directly be linked to a quantified mitigation outcome. Financial assistance for trade financing may also be beneficial for imports of technologies like highly efficient heat pumps that may not be manufactured in the domestic market. Further, international finance, can help provide upfront capital in the form of soft loans to kick-start energy efficient building financing.

Climate finance from international donors has to be complemented with domestic sources. To some extent private capital may be raised through green bond issuances from the Colombian national government itself (sovereign), or through public banks such as Findeter or Bancoldex, as well as through municipalities such as Bogota or Medellin. Sustained political buy and support on a high level in from multiple ministries including the Housing Ministry, the Energy Ministry, as well as the Environment Ministry is essential. There are several points where invested efforts may lose momentum or encounter political challenges that could prevent optimised implementation.

The expected overall emission reduction potential of such a programme is large with major spillover effects (e.g. in other building segments) but challenging to quantify, especially because of a lack of comprehensive existing MRV data, and questions surrounding current practice, enforcement and factoring in an element of supressed demand according to behavioural shifts in various climatic zones. However, for such NAMA type programmes, the question of additionality and baselines are less relevant, as they typically build on ongoing and planned measures in the sector with the intention to integrate and scale-up current efforts. Emission reductions can often not be directly attributed to individual measures, in particular regulations or softer measures designed to enhance the enabling framework, but are assessed more broadly through, for example, log frame-based methods. As these programmes are not designed for crediting, the exact quantification and attribution of the achieved emission reductions is not necessary. Rather, the reductions are accounted for and visible in the GHG pathway of the sector, e.g. under the national inventory system and the domestic MRV system being established to track progress towards Colombia's NDC implementation. The market-based pilot (component 2) can still include a detailed MRV.

6.2 A Nested Market-Based NZEB Pilot to Complement Policy Reform

Future reform, including international support to bring a systemic shift in Colombian housing sector, including social housing, on a path towards decarbonisation will however need to take place step by step – the complexity and heterogeneity of the sector do not allow for overnight transformation. Despite Colombia's recent membership of the OECD, policy makers and stakeholders are not yet ready to implement obligatory measures to leapfrog towards NZEB. Once the benchmarks, methodological framework and monitoring protocol are in place, pilot projects can be developed in select cities to test this approach.

A time limited international market-based pilot programme for NZEB buildings can provide reasonable first experience with the concept of net-zero energy buildings, inform Paris compatible policy reforms and set in motion private sector interest by enhanced incentives. In the longer term, such pilot activity/ies can be reviewed and adapted based on first experiences for net-zero energy building development and then scaled up by embedding it in regulatory reforms.

Such a programme would serve a pioneering role in Colombia, introducing an ambitious precedent for decarbonised building stock that is so far lacking and Colombia would struggle to achieve on its own. It can further reinforce the efforts and objectives of the transformative support programme, while building experience and capacity for a novel approach and promoting technology transfer. Moreover, in light of the ongoing negotiations on the rules for Article 6 of the Paris Agreement, it may be beneficial to set an ambitious precedent that provides an example for how a market based approach promotes new innovative practices in countries that will help set them on a path towards decarbonisation that is necessary for the achievement of the Paris Agreement temperature goals, and to have such an approach nested in comprehensive policy approach that is mutually reinforcing with the goals and practices of the market-based intervention. Such a nested approach has the potential to not only drive emission reductions in the Colombian building sector but could also help add value to the broader discussion on effective mitigation action in the context of NDC implementation.

Market-based NZEB pilot projects can be developed in select cities using the benchmarks and methodological framework developed under the supported programme. We discuss the mechanics of such a pilot in detail in section 4. Considering the issues with resolution 549 benchmarks, the baseline threshold crediting threshold would have more ambitious one and based on a reformed Resolution 549 (as discussed in section 4). The difference between emissions in the baseline benchmark based on a reformed Resolution 549 and the 'ambition trigger' or when NZEB status has been reached will lead to issuance of credits. Such an ambitious pilot represents additional emission reductions that are almost certainly out of reach of Colombian housing policy makers now and would lay the groundwork for raising Colombia's NDC ambition in future rounds. An additional 'net-mitigation' contribution could be integrated to achieve an overall reduction in greenhouse gas emissions that would not be used to demonstrate achievement of either the Colombian NDC or the acquiring country's NDC.

The proposed NZEB would likely lead to higher initial upfront costs for the project developers compared to either business as usual, or the minimum required for compliance with Resolution 549 and the Sustainable Building Guide. This is because the additional cost of installed efficient appliances would need to be included in the housing unit – though some of these costs could be addressed through an ESCO model, where upfront costs are repaid through a portion of future savings in energy bills. Administrative and transaction costs associated with the crediting element which include regular monitoring will also increase costs compared to a non-crediting approach, however some of these costs could be reduced through and in synergy with smart meter market penetration.

A market-based pilot will have to be based on an MOU between the donor and the Colombian government on details of ITMO transfer. The pilot could, for instance, be started through the establishment of an entity that would publicly tender for joint bids where an ESCO and construction company cooperate to build the NZEB (including basic super-efficient energy use products). Forming a partnership through an ESCO where future savings would in part be recouped by the ESCO, could offset some of the upfront costs. Such an ESCO model would also be able to take advantage of the value added tax reductions for renewable energy equipment that are not currently available for housing owners. The significant upfront costs however are likely to require upfront support, which is has not generally been the approach of, for example the Clean Development Mechanism. Some "greened" AAU transfers however, as part of "Green Investment Schemes" provide a precedent for upfront payments for emission reductions, however in this case the pilot would more directly link the transfer to additional emission reductions, which was not necessarily a requirement for GIS, which often focused on selling a surplus of unneeded AAU units. In section 4, we discuss some details of developing such a NZEB pilot using international cooperation under Article 6. However, depending on mutual agreement between the Colombian government and donors, these pilots could work on results-based finance as well.

6.2.1 Implications for Domestic Carbon Pricing Instruments

As discussed in section 2.8, Colombia has experience with the CDM as a non-annex 1 country, has instituted a carbon tax with a voluntary offsetting element, has a draft legislative basis for an Emissions Trading System, and is in discussions with a number of countries and jurisdictions on further cooperation for carbon market approaches in the future. The tax has generated domestic Colombian demand for carbon credits, and in theory could constitute a future source of demand for credits produced from a NZEB pilot as well. However, the tax is set at approximately 5 USD, a level that is likely lower than the per tonne price of reductions achieved through the NZEB pilot, although such calculations further depend on a number of factors including discount factors, and the length of crediting periods. Conversations with government officials and stakeholders indicate that considerations for an emissions trading scheme are still in conceptual stage and that it is currently hard to speculate with regard to its future development, including coverage or any provisions for offsets. Other potential market considerations including bilateral agreements between Colombia and other countries are equally yet to be fleshed out.

6.2.2 Implications for Colombian NDC and Future Ambition

The pilot has several implications for further implementation of the Colombian NDC, future ambition, and general engagement with Article 6 of the Paris Agreement. The ambitious nature of the NZEB pilot, and its potential role in helping the sector to leapfrog to decarbonised building practices are likely to alleviate any concerns of Colombia selling its cheapest emission reduction options even if they may come at a net negative overall long-term cost to the country. The scope of the pilot can objectively be said to not be common practice and given existing patterns and structures in the construction sector, may not be financially accessible of feasible for either real estate developers / construction companies / ESCOs or lower income homeowner associations. Once capacities have been built under the pilot, Colombian government can consider raising its ambition in the sector towards sectoral decarbonisation.

Domestic double counting between the contributions towards the energy and building sector is likely to continue to be a challenge, especially with regard to the shared competences for some energy efficiency measures regarding energy use, electrification, and renewable energy deployment in buildings.

Avoiding double counting for ITMO however may also be a challenge and a revision of the Colombian NDC towards quantified, multi-year annual budget may be considered to mitigate this risk. If that were to be undertaken however, risk of double counting internationally is likely avoidable though this also depends on the NDC of the acquiring country and rules and guidance for such international transfer still under negotiation.

7 Conclusions and Recommendations

Colombia's building sector represented almost 26% of total energy consumption in 2014. Although relatively low consumers of energy, residents of social housing (VIS/VIP) receive both significant subsidies from the state and are vulnerable to energy poverty. Although the electricity sector is comparatively clean thanks to Colombia's hydroelectric resources, the el Nino / la Nina phenomenon means that hydro resources will become less certain in the future. Although the overall population growth rate is low, Colombia's rapidly growing and urbanizing urban populations will require a large increase of housing and infrastructure expansion. At the same time, radical improvement of the building sector and longer term complete decarbonisation is an urgent challenge to address in order to meet the needs of Colombia's population, and meet the objectives of the Paris Agreement to limit global warming to well below 2°C and reach a balance between emission sources and sinks in the second half of this century. There are a number of challenges associated with the effort, but despite some increased upfront costs, much of this can be done at negative costs at both the household and national levels for both new buildings and the existing building stock. In addition to domestic efforts, international cooperation, both through international climate finance and possibly also through the opportunities presented through Article 6 of the Paris Agreement, may present options to steer the Colombian building sector towards a more climate compatible path while improving living standards and realizing significant sustainable development benefits.

The building sector in Colombia, as elsewhere, presents a number of challenges for energy efficiency measures in general and especially for emission reduction crediting. These include, inter alia, a large number of stakeholders involved; fragmented market and institutional structures, challenges of enforcing existing building guidelines; high heterogeneity with vast variances in building practices through time. These are related to, cultural aspects, cognitive and behavioural patterns in different geographic regions, and between construction firms. A large number of measures would lead to comparably small emissions savings given the relatively low emission electricity grid in Colombia. Other challenges include transaction costs, long investment payback periods; limited capital / access to financing, risk aversion, distorted tax regimes and energy consumption subsidies, patents and barriers to technology transfer as well as a lack of information and awareness hinder investments to be made. The energy subsidies that form part of the Stata system in Colombia are further an important financial burden on the Colombian government. Further monitoring and verification of energy performance and energy performance improvement pose challenges as well as high transaction costs (Lucon et al., 2014).

These challenges made project-based crediting in the building sector impracticable in the CDM, both in Colombia and around the world. Most CDM projects in the household energy efficiency area concentrated on single interventions such as light bulb replacement or cookstoves but failed to bring about a transformational shift towards efficient building practices. A sectoral approach may address some of these barriers but still presents a major challenge, and are likely not practicable given the principles outlined in the Paris Agreement for Article 6 on internationally transferred mitigation outcomes. Longer term sector wide planning will be required to chart a pathway towards decarbonisation for the sector as a whole.

At the same time such longer term planning has limited potential to provide shorter-term incentives for first movers to innovate and go beyond minimum requirements. NZEBs and their role in deep decarbonisation of the residential buildings sector is currently not under consideration in either the market, policy or development cooperation circles of Colombia and the country has not yet submitted a long term decarbonisation strategy. Pilot projects demonstrating NZEB could therefore fulfil an important niche in setting an ambitious precedent to introduce efficient,

sustainable building practices in the sector and help Colombia leapfrog to a deep decarbonisation pathway in the sector. Moreover, it can provide an iterative process to inform policy orientation towards decarbonisation. Ambitious donors may therefore find the approach of facilitating introduction of NZEBs by nesting market-based pilots under a transformative policy support programme attractive option to gain experiences with post-Paris climate finance and carbon finance cooperation, while supporting sectoral transformation in Colombia.

Overall, to respond to the future needs of the sector, reduce energy consumption and emissions, while charting a pathway consistent with the Paris Agreement and reducing expensive government subsidy payments, we make the following recommendations:

21. Develop a long-term target and strategy for net-zero energy for buildings as part of a long term decarbonisation strategy.
    a) Such a target could be set by the CONPES, including a scale that can depict and rachet towards net-zero energy. Such planning should take into consideration the freed up financial resources that would otherwise have gone towards energy consumption subsidies.
    b) Such a target should focus on new buildings first to avoid high energy and emissions lock in, to be accompanied by efforts to improve the energy efficiency of existing building stock through retrofits and other energy efficiency measures such as appliance standards.
22. Start small and scale up
    a) Colombia, together with ambitious international partners could consider a NZEB pilot to demonstrate innovative business models and best available technologies, reward early movers, and push improved practice penetration.
23. Address urbanisation trends by focussing on regions with rapid population growth, including social housing demand
    a) The Bogota metropolitan area, Medellin, and Cali are likely to represent the vast majority of population growth and construction. These municipal governments have comparatively good capacity for climate policy action, have the political will, and are already undertaking measures to reduce emissions from building stock, such as through the BEA program. The focus of energy efficiency efforts should be focussed in these cities.
    b) In a second step, ambitious medium size cities could be added to capacity building efforts, potentially in partnership with already trained colleagues from the larger metropolitan areas.
24. Update and reform the sustainable construction guide
    a) Although the sustainable construction guide is currently voluntary for social housing, the associated costs of many of the energy efficiency measures have come down since the guide was first published. A reform and optimisation of existing practices and technologies can lead to substantial reductions in energy consumption; this can be achieved without further national or international support. Capacity development and the provision of tools to facilitate compliance can help stakeholders to comply with reformed mandates.
    b) Even for buildings built in the next few years that do not include the renewable energy generation on site (PV and solar hot water heaters), building designs should begin to require roofs that can easily accommodate future installation of such technology. This is a low cost way to facilitate future measures to move towards a decarbonised building sector.
    c) Increase flexibility. Moving from a prescriptive list of technologies to an efficiency standard leads to higher savings. Such flexibility reduces administrative burden and allows developers to quickly innovate and react to new technologies and approaches.

d) Simplify: Baseline setting for sectors is challenging and can become rapidly outdated. Measurement of energy efficiency in the housing sector should shift from a '% and measures' approach to 'absolute minimum energy consumption (energy/square meters)'.

25. Define a robust compliance regime

a) Adherence with energy efficiency regulations should be integrated into the POTs of municipalities. These should mandate regular data collection to check compliance, synergies can be found with government planning for the installation of smart meters throughout Colombia by 2030.

b) Define a clear way to show compliance with resolution 549 - develop own certification tool or adopt an existing one (EDGE, LEED, others), and train / equip curadores to check compliance through on-site verification.

26. Beyond building design, implement policies on:

a) Mandatory and regularly updated mandatory minimum energy performance standards can further aid the transition especially for appliances and lighting. This can be accompanied with policies that Colombia already has experience with such as the phase-out of inefficient products as in the case of incandescent light bulbs.

b) Colombia has recently implemented regulations governing net-metering. Further promotion of on-site solar thermal and PV in homes for home owners/tenants can further improve the emissions profile of the Colombian building sector.

c) Develop targeted policies to electrify for cooking and water heating, to reduce natural gas use and demand.

27. Provide incentives to go beyond minimum requirements

a) Instruments of ‚recognition', can provide a motivation to go beyond minimum mandated standards, these can include housing labels / stretch standards and competitions and awards (for net-zero demonstration buildings)

b) Incentivise more ambitious developers. Such incentives could include preferential interest rates from local banks for very energy efficient houses beyond the current Bancolombia and Davivienda programmes; reduced VAT rates, and or prioritisation for construction permits. link incentives to housing labels, stretch codes, certificates that go beyond res. 549

28. Explore a role for ESCOs for the residential sector

a) Such support could include policy support e.g. VAT exemption, subsidised loans or programmes to encourage ESCO collaboration with construction companies.

29. Improve coordination and exchange between stakeholders

a) Alignment between ministries roles and responsibilities for example through special task forces that include a number of different relevant government agencies for example the Environment Ministry, Energy Ministry and Housing Ministry, and local government.

30. Build new capacities

a) Formalise regulatory roles - who plans, who coordinates, who implements, who monitors, who verifies, who reviews, who enforces.

b) Concentrated effort to build capacity of local governments to integrate energy efficiency and distributed renewable energy generation standards into local planning regulation (their Plan de ordenamiento territorial or POT), as well increase enforcement capacities

c) Train and expand the number of certified building inspection engineers.

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9 Annexes

Annex I: List of interviewees

The project team undertook three missions to Colombia – in September 2016, March 2018 and September 2018 – to interview the following experts from public, private and non-governmental institutions.

No.	Institution	Experts
1	Ministerio de Ambiente y Desarrollo Sostenible (MADS) (Ministry of Environment)	Giovanni Andrés Pabón Restrepo Sebastian Carranza Santiago Uribe Cuentas Erika Ginett Amaya Rabe
2	Ministerio de Vivienda, Ciudad y Territorio (MVCT) (Ministry of Housing, City and Territory)	Diana María Cuadros July Gonzalez Martin Phillips Botta (former) Carolina Hernández
3	Ministerio de Minas y Energía (MME) (Ministry of Mines and Energy)	Eduardo José Sánchez Daniel Mendoza
4	Departamento Nacional de Planeación (DNP) (National Planning Department)	German Romero José Antonio Pinzón Bermudez Alexander Rodriguez Natalia (?)
5	Unidad de Planeación Minero Energética (UPME) - Energy & Mining Planning Unit	Olga Gonzalez Jonathan David Sanchez
6	Department for Investments in Social Housing (DIVIS) – MVCT	Richard Perafán Sandra Vargas Navas Eduardo Salas Delgado Carlos Díaz Reyes
7	City of Bogota, Planning Department	Jaydy Salazar Sandoval Juan Manuel
8	International Finance Corporation (IFC)	David Serna (former)
9	Latin American Development Bank (CAF)	Alejandro Miranda
10	Universidad de los Andes	Angela Cadena

		Jose Alberto Guevara Maldonado
11	Cámara Colombiana de la Construcción (CAMACOL) (Colombian Chamber of Construction)	Victoria Cunningham Nestor Jaimez
12	Consejo Colombiano de Eficiencia Energética, CCEE (Colombian Council on Energy Efficiency)	Gonzalo Benavides
13	Colombian Green Building Council (CCCS)	Sarah Arboleda Osorio Camilo Luengas Bernal Cristina Gamboa Natalia Arango Nader
14	Caia	Alexander Valencia
15	GIE	Paula Andrea Rodriguez Hector Aristizabal
16	EPB Chile	Roger Walther
17	Bancolombia	María del Mar Vélez Mejía

Annex II: Institutional and stakeholder overview

This section provides an overview of the main institutional authorities relevant in the context of the activities planned under the pilot. This includes national government authorities, actors at the subnational level as well as NGOs and donor agencies active in the sector.

9.1.1 National Government

National Planning Department (DNP) – The Colombian National Planning Department is responsable for Colombia's national development plan, which is updated every four years. It serves as a kind of think tank for the country, proivdes budget recommendations from the Hacienda and serves at the National Focal Point for the Green Climate Fund. Recommendations for the Colombian carbon tax were fist elaborated in the DNP in coordination with the IMF.

Ministry of Housing (Ministerio de Vivienda, Ciudad y Territorio – MinVivienda)

The Ministry of Housing in its current form was founded in 2011. It is responsible for the formulation, adoption, coordination and execution of public policies, plans and projects in the field of urban housing, safe drinking water, sanitation and spatial and urban development, promoting patterns for the generally efficient and sustainable use of soils. It aims at contributing to social equity and quality of life through the strengthening of cities and improvement of universal public access to adequate and decent housing and to basic water and sanitation services.51

During the first country mission, the Ministry of Housing was confirmed as the main counterpart for the project activities. It was agreed that the Ministry would coordinate with the relevant national actors throughout the project.

For the Ministry of Housing, the main interest remains in the social housing sector and the establishment of a financial incentive scheme to mobilise investments in energy efficiency in the sector. The recently adopted Green Buildings Guide is not mandatory for the social housing sector, hence may not sufficiently drive energy efficiency improvements in this subsector.

Ministry of Environment (Ministerio de Ambiente y Desarrollo Sostenible – MinAmbiente)

The Ministry of Environment is in charge of defining a national environment policy and promotes the recuperation, conservation, protection, regulation, management and efficient use of renewable natural resources, aiming at ensuring sustainable development and the right of all citizens to a healthy environment. The ministry is in particular committed to the improvement of environmental quality through strengthening the environmental performance of the productive sector and of different actors with a view to implementing and monitoring environmental policies and guidelines.52

For the Ministry of Environment, the key interest in the pilot lies in the exploration of the potential use of crediting schemes in the context of the country's nationally determined contribution (NDC). Colombia is currently undertaking research into the applicability of different economic and pricing instruments, including a national emissions trading scheme and carbon taxation. The pilot will provide useful additional insights into the potential role of a sectoral crediting scheme in the Colombian context.

Ministry of Energy (Ministerio de Minas y Energia – MinMinas)

51 See: The following link leads to the internet: http://www.minvivienda.gov.co/sobre-el-ministerio/mision-y-vision (accessed: 20.01.2017).

52 See: The following link leads to the internet: http://www.minambiente.gov.co/index.php/ministerio/mision-y-vision (accessed: 20.01.2017).

The Ministry of Energy is responsible for the management of non-renewable natural resources, ensuring their development and efficient use and providing orientation for their regulation. The ministry is furthermore committed to the protection of the environment, ensuring its conservation, restauration and sustainable development in accordance with criteria outlined by a national environmental authority. Through the formulation and adoption of respective public policies, the Ministry of Energy aims at contributing to the economic and social development of the country.53

- Mining and Energy Planning Unit (Unidad de Planeación Minéro-Energética – UPME)
- Colombia's national Mining and Energy Planning Unit (UPME) is a special administrative unit that is linked to the Ministry of Energy. UPME is responsible for the sustainable development of the country's mining and energy sectors, including hydrocarbons, and supports the formulation of public policies as well as the coordination of information across different sector stakeholders.[54]
- Energy and Gas Regulation Commission (Comisión de Regulación de Energía y Gas – CREG)
- The Energy and Gas Regulation Commission (CREG) is a special administrative unit of the Ministry of Energy founded in 1994 (through Law 142/1994). It is the regulatory body for the Colombian power sector and is in charge of regulating public utilities that provide electric energy, natural gas and liquefied petroleum gas (LPG). CREG promotes the sustainable development of the power sector, regulates monopolies and encourages competition where possible in order to meet the needs of users and producers in accordance with the criteria established by law.[55]

Intersectoral Climate Change Commission (Comisión Intersectorial de Cambio Climático – CICC)

In 2016, the Ministry of Environment established the Intersectoral Climate Change Commission (CICC) through Decree 298/2016 as the coordinating and organising body for implementing the **National Climate Change Policy** that is currently being developed. The CICC is composed of representatives of the Ministry of Environment, Ministry of Interior, Ministry of Finance, Ministry of Agriculture, Ministry of Energy, Ministry of Transport, Ministry of Foreign Affairs and the director of the National Planning Department. Functions performed by the CICC include: the establishment of policies and actions to achieve the Colombian climate change targets; the definition of criteria for the allocation of respective resources in the budget of each ministry; the support and formalisation of intersectoral commitments and compromises; the issuance of general instructions and solicitation of reports; the promotion of different mechanisms between the National Government, territorial entities and the private sector that allow for a joint implementation of policies; the coordination and definition of a strategy for monitoring, evaluation and reporting on the National Climate Change Policy; and the creation of technical committees needed for the fulfilment of its functions. As a minimum, a Financial Management Committee and an International Affairs Committee shall be created under the CICC (Ministerio de Ambiente y Desarrollo Sostenible, 2016).

[53] See: The following link leads to the internet: https://www.minminas.gov.co/mision-y-vision (accessed: 20.01.2017).

[54] See: The following link leads to the internet: http://www1.upme.gov.co/quienes-somos (accessed: 26.01.2017).

[55] See: The following link leads to the internet: http://www.creg.gov.co/ (accessed: 27.01.2017).

9.1.2 Sub-National Level

Regional Climate Change Nodes (Nodos Regionales de Cambio Climático)

Decree 298/2016 also establishes Regional Climate Change Nodes as regional authorities responsible for promoting, accompanying, and supporting the implementation of policies, strategies, projects, programmes and actions with regard to climate change within the regions. The objective of these nodes is to manage the interinstitutional coordination between the central and territorial levels to enhance national and regional climate change processes. The Decree establishes nine Regional Nodes: Amazonía, Orinoquía, Centro Oriente Andino, Norandino, Eje Cafetero, Antioquia, Caribe e Insular, Pacífico Norte, y Pacífico Sur that each cover certain departments (Ministerio de Ambiente y Desarrollo Sostenible, 2016).

9.1.3 Private Sector and Interest Groups

Bancolombia and Davivienda

Bancolombia and Davivienda are the two largest private financial institutions active in contruction finance, as well as local mortgage finance. Both have launced Green Bonds to offer construction companies preferential interest rates for buildings projects that adhere to sustainability criteria. House buyers who buy housing units in sustainable buildings also recieve preferential interest rates.

The Colombian Green Buildings Council (Consejo Colombiano de Construcción Sostenible – CCCS)

The CCCS is a private non-profit organisation that was founded in 2008. It promotes the transformation of Colombia's cities and building industry towards sustainability, primarily through offering trainings, campaigns and specialised events. It operates as an association that brings together more than 200 members from the public and private sector (including companies, universities, NGOs, forums etc.). Services include the selection of tools for verification and certification of sustainable construction to inspire industry and markets; the support for formulation of public policies and generation of incentives for sustainable construction; capacity building etc. The CCCS is a member of the World Green Building Council.56

Colombian Construction Chamber (Cámara Colombiana de la Construcción – CAMACOL)

CAMACOL is a non-profit professional association, founded in 1957, that brings together national businesses and professionals related to the construction value chain. CAMACOL looks after the interests of the construction industry and is constituted by constructors, industry representatives and the commercial sector. It aims at taking leadership for a responsible and sustainable urban development, ensuring a decrease of the housing deficit and opening the sector towards new business opportunities and markets.57 CAMACOL also participated in the process leading to the adoption of Colombia's Sustainable Building Guide.

9.1.4 International Development Organisations Active in the Colombian Building Sector

International Finance Corporation (IFC)

IFC is a member of the World Bank Group and the largest global development institution focused exclusively on the private sector in developing countries. In Colombia, which is a member of IFC since 1956, the institution primarily supports infrastructure development through public-

[56] See: The following link leads to the internet: https://www.cccs.org.co/wp/acerca-del-cccs/ (accessed: 23.01.2017).

[57] See: The following link leads to the internet: http://camacol.co/camacol/quienes-somos (accessed: 23.01.2017).

private partnerships, aiming at building well-functioning ports, roads, and airports, and at promoting environmentally and socially sustainable business practices.

The IFC implemented an advisory project in Colombia starting in 2011, it continues to support the country in developing its first Sustainable Building Guide in order to promote energy efficiency and water conservation in building construction. Through offering a cost-benefit methodology and global expertise for the development of green building codes in other countries such as Vietnam, Bangladesh and the Philippines, IFC facilitated a public-private dialogue to identify barriers in the construction sector and promote the development of sustainable building guidelines (IFC, 2015).

Annex III: Colombia's Negotiating Position Under the UNFCCC and AILAC Views on Article 6

Colombia signed the Paris Agreement but as of April 2018 had not yet ratified58. Colombia is one of the six countries (together with Costa Rica, Chile, Peru, Guatemala and Panamá) that jointed together to form the Association of Independent Latin American and Caribbean states (AILAC). In the UNFCCC negotiations, the AILAC group encourages countries to step up their climate commitments and advocates an ambitious, comprehensive and legally-binding international agreement. AILAC supports the swift development of rules, modalities and procedures for the use of Article 6. Key priorities are the definition of internationally transferable mitigation outcomes (ITMOs), their accounting, the relationship between Art. 6.2 and 6.4 as well as a reflection on the experiences gained in the implementation of the Kyoto Protocol mechanisms.

With regard to the use of market instruments, AILAC countries mentioned in the run up to Paris that they would not rule out utilising market mechanisms in a future carbon market but that they were concerned with the overreliance on carbon markets to achieve the global climate goal. They therefore proposed that any market-based mechanism must include incentives for driving action and catalysing ambition at scale. After Paris, AILAC submitted two proposals to the UNFCCC on Article 6 of the Paris Agreement.

According to the first submission dated October 2016, AILAC countries are united in their support of transparency and overall ambition as key principles for the implementation of Article 6. Robust guidance for Art. 6.2 (cooperative approaches) and robust rules, modalities and procedures for Art. 6.4 (sustainable development mechanism) must be at the core of future carbon market development (AILAC, 2016).

In their submission from April 2017, priority is given to the definition of ITMOs, the accounting of ITMOs, the modalities of the mechanism under Art. 6.4, and the relationship between Articles 6.2 and 6.4.

Their position can be summarised as follows:

- ITMOs transferred under cooperative approaches should be expressed in terms of tonnes of CO2 equivalent, building on a common unit that already has been used as part of the Convention process.
- With regard to the accounting of ITMOs, experience from the implementation of the Kyoto Protocol can be used as input to avoid double counting and ensure environmental integrity (placing emphasis on decisions 12/CMP.1 (guidance for registry systems); 13/CMP.1 (modalities for

58 Current ratification status can be found here: https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-7-d&chapter=27&clang=_en

accounting of assigned amounts); and 14/CMP.1 (standard electronic format for reporting Kyoto Protocol units).

- CDM and JI provide a solid basis for any new international mechanism to be developed under Art. 6.4.
- A potential new international mechanism under Art. 6.4 can include project-based, programmatic, sectorial and other initiatives that can receive credits for emissions reductions achieved.
- Potentially, also emissions reductions from other international standards/ mechanisms/ programmes outside the UNFCCC can be considered to participate in the mechanism under Art. 6.4, if certified accordingly by the Governing Body.

AILAC countries see a strong link between Articles 6.2 and 6.4, allowing the transfer of mitigation outcomes generated and certified under the sustainable development mechanisms (Art. 6.4) to any form of cooperative approach (Art. 6.2), to facilitate a country's NDC implementation (AILAC, 2017).

Afterword: Considerations for Article 6 engagement: The host country perspective

At the time of writing, the exact guidance, rules, modalities, and procedures for engagement through Article 6 remain the subject of ongoing negotiations. Important aspects of the new Paris world are however clear: the universal commitment to regularly make increasingly ambitious contributions towards the global effort, and the three principles of allowing for higher mitigation ambition, promoting sustainable development, and ensuring environmental integrity are already solidly anchored in the Paris text. This present new challenges for carbon markets, especially for host countries.

Based on this research project and other recent literature on rules and perspectives on engaging with carbon markets under the Paris Agreement the research team has written an additional report to serve as input for policy makers considering Article 6 engagement. Published as a separate document, it discusses rationales for a country to engage in Article 6, how carbon market engagement relates to other aspects of national climate policy making and the fulfilment of commitments under the Paris regime. In addition, the report explores aspects relevant for the oversight and implementation of on how to implement projects on the ground and decision making for achieving overall mitigation in global emissions Article 6 from the host country perspective. Further aspects discussed include approaches to proposal evaluation, finding potential partners, as well as the choice between engagement through Article 6.4 and Article 6.2. The document then goes on to sketch out interlinkages between Article 6 participation, national policy making and other obligations under the Paris Agreement. A conclusion then includes a brief outlook for carbon markets. We hope that the insight and learnings will help inform decision making both regards to Article 6 negotiations as well as engagement going forward.