

助力新达峰目标与碳中和愿景 ——戮力同心，共筑绿色未来

波士顿咨询

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综述

气候变化让人类站在了事关自身命运存亡的历史关头。如果不加以积极干预，本世纪末全球气温将上升 5°C 以上，粮食将减产 50%，75%的物种将面临灭绝。为遏制全球变暖的严峻趋势，作为高速发展的碳排放大国，中国承诺争取在 2060 年前实现碳中和目标。为实现这一目标，中国必须坚持沿着将气温上升控制在 1.5°C 框架内的可持续发展之路，在 2050 年之前实现 75-85%的碳减排。除履行大国责任外，中国对减排目标的积极追求将为其在可持续发展、直接经济促进和国家能源安全上带来切实利益。

为实现上述宏大减排目标，中国政府应发挥引领作用，大力发展绿色能源与绿色金融，加速关键行业的绿色转型。实体企业应当抓住减排机遇，制定绿色发展战略并打造可持续供应链，拥抱绿色未来。金融机构应建立绿色金融发展能力，通过专业化运营促进绿色产业发展。

中国碳排放来源以能源与工业为主，自 2013 年以来已进入平台期。为实现碳中和承诺，中国需要沿着 1.5°C 减排路径不懈努力，在能源、工业、交通、建筑、农业与土地利用等五大部门均需推进减排。截至 2050 年，我们预计完成减排目标各项举措所需累计投资为 90-100 万亿人民币，约占 2020-2050 年累计 GDP 的 2%。其中，由于技术成熟度等方面的原因，交通部门所需投资最大，主要包括推广新能源汽车和氢燃料，倡导公共交通出行。能源部门次之，主要由可再生能源、核能发电以及碳捕获与储存技术（CCS）的研发与应用拓展驱动。除此以外，工业部门的工艺流程创新、建筑部门的热泵技术、农业与土地利用部门的垃圾焚烧处理也将占据较大的投资份额。

- **政府：**中国的大力低碳转型应以发展绿色能源与绿色金融为关键抓手。在绿色能源方面，中国需要在需求与供给两端同时积极推动能源转型。在绿色金融方面，中国需要由政府从监管、激励政策和基础设施三方面进行主导和推动减排。
- **企业：**企业是中国绿色经济发展的生力军，已经在积极开展绿色探索和实践。我们建议，企业可以通过现状评估、目标制定与减排举措评估来实现更为高远的减碳目标。目前企业的碳排放主要来自电力与燃料消耗。企业自身的主要减排举措可多达 200 余项，包括能源结构转型、模式升级、能效提升以及碳捕获等。企业应综合多方因素，制定减排曲线，选择成本效益高且可行的减排路径，并赋能组织确保绿色转型落地。
- **金融机构：**作为减排合作中的关键一环，中国的金融机构应致力于提升绿色价值创造，助力实体产业加速实现可持续发展目标，以此为基础实现绿色战略愿景。金融机构可以通过明确绿色发展重点支持领域，并推动产品与业务模式创新以及打造运营支撑来强化绿色金融的专业化运营能力。

中国既是碳排放大国，也是绿色能源技术发展和土地绿化的表率。在未来，中国推进可持续发展战略和减排举措的实施，必将对世界产生重大影响。中国每个相关部门、企业与个人，都应持续关注低碳减排这一重大课题，并通力合作采取行动。

1. 气候变化亟需各界通力协作，中国肩负净零重任

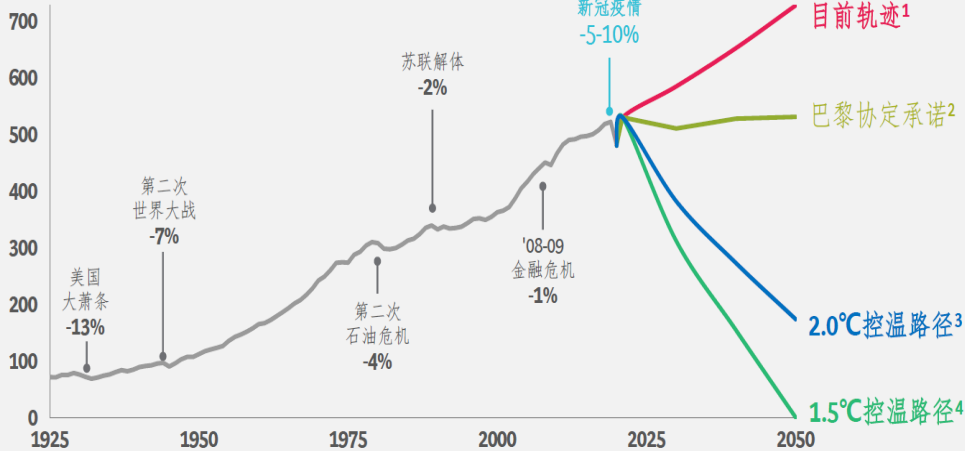
1.1 气候变化事关人类存亡，世界尚未采取足够有效行动

近年来，大气层二氧化碳浓度已达到 2500 万年以来的最高值。联合国秘书长古特雷斯于 2018 年 9 月在纽约联合国总部就气候变化问题发表讲话时指出：“气候变化让人类站在事关存亡的十字路口。”若不加以积极干预，到 2100 年全球温度预计将上升 5℃，对人类社会造成毁灭性打击：75%的物种将濒临灭绝，粮食产量可能下降 50%，由此带来的饥荒、移民、冲突在人类历史上曾无数次引爆战争甚至文明崩塌。

为减缓气温上升速度，全球 196 个国家在 2015 年的《巴黎协定》中承诺，将共同努力把全球气温上升控制在 2℃之内。这意味着全球将在本世纪末实现净零排放，大气碳浓度控制在 430—480 ppm，海平面上升控制在 0.6 米以下。然而时至今日，大多数国家尚未采取有效行动兑现 2015 年签署的《巴黎协定》。

图1 | 本次新冠疫情期间，温室气体排放减少了5~10%，是第二次世界大战以来最大降幅，为加快减排行动带来契机

全球温室气体排放量（亿吨二氧化碳当量）



来源：EEA；EDGAR 5.0；EC；IEA；FAO；PRIMAP-hist v2.1.1；《全球碳项目》；IPCC；联合国环境规划署排放差距报告；WRI；Nature (2020年5月)；BCG分析。
 注：这些数据不包括土地使用、土地利用变更以及森林的排放。
 1. 假设2020年至2050年温室气体排放的增长水平保持不变，增长率为联合国环境规划署《2019排放差距报告》中目前政策场景下的水平（年复合增长率为1.1%）。
 2. 新公布的排放路径，反映了中国、欧盟、日本、韩国和阿根廷等国“净零”的目标。
 3. 2.0°C控温路径假设到2030年减排25%，到2070年实现“净零”。
 4. 1.5°C控温路径假设到2030年减排~50%，到2050年实现“净零”。

1.2 新冠肺炎疫情“黑天鹅”为加快减排行动带来了契机

据欧洲环境署和联合国环境规划署等机构统计（参阅图 1），疫情期间，由于各国在新冠疫情期间实行封锁和限制行动，温室气体排放减少了 5-10%，是第二次世界大战以来最大降幅，创下了历史纪录。2020 年全球预计减少 24 亿吨碳排放量，远大于以往的年度减排纪录，如二战结束时的 9 亿吨或 2009 年金融危机最严重时的 5 亿吨。

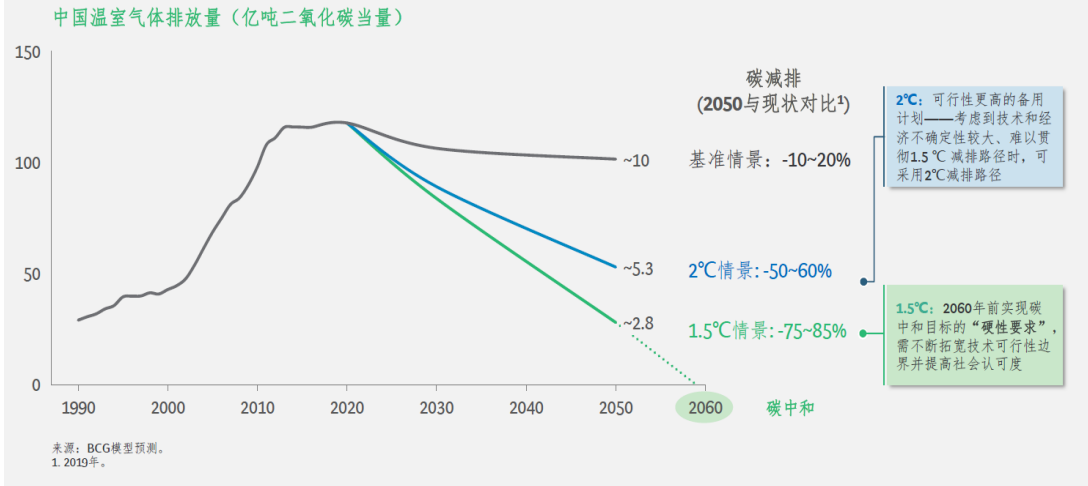
全球碳项目（Global Carbon Project）在其 2020 年度评估中表示，美国（下降 12%）和欧盟（下降 11%）因疫情的减排最为明显。然而由于中国超强的经济复苏，2020 年中国碳排放量可能仅下降约 1.7%。

1.3 面对全球变暖的严峻形势，中国展现出负责任的大国担当

2020 年 9 月，习近平主席在第七十五届联合国大会上郑重承诺：中国二氧化碳排放力争于 2030 年前达到峰值，努力争取于 2060 年前实现碳中和。人类不能再忽视大自然一次又一次的警告，各国应携手推动后疫情时代世界经济的绿色复苏。中国在 2060 年前实现碳中和的承诺，与《巴黎协定》的 1.5°C 升温控制目标高度一致。

该承诺体现了中国携手世界努力遏制气候变暖、控制全球升温幅度的长久愿景，同时也代表着中国将为此愿景积极投入的无悔决心。我们通过分析发现，如果要在 2060 年之前实现碳中和目标，中国须立刻开始行动并沿着 1.5°C 路径不懈努力，力争在 2050 年前实现 75-85% 的温室气体减排（参阅图 2）。在这一路径下，中国需要在当前减碳计划的基础上大幅加大投入，不断拓宽技术可行性边界，并提高社会对减碳的认可度。

图2 | 中国须即刻起坚持1.5°C发展之路，并在2050年前实现75~85%碳减排



1.4 积极减排将在三大方面让中国获益

除履行大国责任外，中国追求积极的减排目标还能在发展的可持续性、直接经济促进和国家能源安全等方面收获切实利益。

- **发展的可持续性:** 更高的减碳目标能帮助中国减少可预见的自然灾害、改善人们的生活品质。如果不采取进一步措施，在目前趋势下，天灾、疾病和资源匮乏等恶果将越来越频发。例如，国内热浪的持续时间至2050年将在现有基础上增长10倍，一年中将长达12天。与此同时，洪水的频发将对中国沿海、沿江等经济发达与人口密集地区造成进一步影响，预计2050年将造成2万亿人民币的直接经济损失。

- **直接的经济促进：**对绿色经济的持续发展将能够直接提升中国中长期GDP和就业率。根据我们的测算，在向碳中和目标行进的过程中，在1.5℃目标下，绿色技术投资至2050年将贡献2-3%的中国GDP。根据国际可再生能源署（IRENA）的预测，仅在2℃路径下绿色经济相关的可再生能源、建筑、交通等行业至2030年也能够为中国带来约0.3%的就业率提升。
- **国家能源安全：**通过进一步发展风能、光伏等可再生能源和绿色科技，中国能够大幅减少对进口及不可再生能源的依赖，对于提高国家能源安全有重要的战略意义。目前，中国在风能和光伏方面的投资名列世界前茅，并且拥有全世界三分之一的可再生能源专利，但仍需再接再厉。根据我们的测算，在向1.5℃目标行进的过程中，到2050年中国对化石能耗需求将降低约80%。

1.5 实现宏伟减碳目标，需要政府、企业与金融机构通力协作

首先，中国政府将以发展绿色经济和科技为重点。“十四五”规划中重点发展绿色产业成为主旋律，加速推动能源、工业等关键产业的转型。为了更有效地推动碳减排，中国还应积极推动绿色能源的结构转型与绿色金融体系的发展，引导社会资本向绿色产业公司配置，进而促进绿色产业的发展。

其二，虽然目前面临诸多困境，但企业也应积极与政府携手，把握疫情期间碳排放下降的契机，实现“绿色复苏”。电力/热力等相关重点排放企业须积极布局发展绿色能源，其他企业也应该在政府激励政策助力下，主动采用绿色能源。此外，响应“中国制造 2025”的号召，企业还应该积极打造绿色供应链，从上游出发，加快建立以资源节约、环境友好为导向的采购、生产、营销、回收及物流体系，落实生产者责任延伸制度。

其三，绿色金融指对环保、节能、清洁能源、绿色交通和建筑领域的投融资、运营、风险管理等方面提供金融服务。金融机构需系统化打造绿色金融战略，优化资源配置，进一步服务绿色环保产业和环境友好型的先进制造业、服务业和新兴产业，助力经济转型升级。金融机构还应积极进行绿色金融的业务模式创新，通过绿色信贷、绿色债券、绿色股票和绿色发展基金等金融工具，为绿色金融发展提供可持续的推动力。

2. 中国政府应发挥引领作用，发展绿色能源与绿色金融，加速关键行业的转型

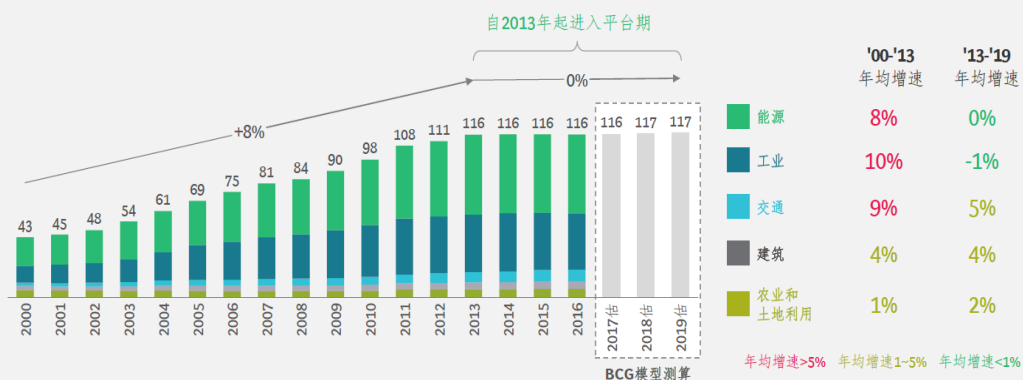
2.1 中国碳排放来源以能源与工业为主，自 2013 年以来已进入平台期

过去的 20 多年既见证了中国经济的快速发展，也是中国成为碳排放大国的历程。2013 年之前，中国碳排放增长率长期维持在约 8%的水平。2013 年后，随着经济增长趋缓，以及节能减排措施力度的加大，碳排放进入平台

期。中国温室气体排放主要来自能源、工业、交通、建筑、农业和土地利用五大部门。其中能源和工业部门占比最大，合计贡献了超过 80%的碳排放。2013 年后，这两大部门的碳排放增长也进入平台期，甚至出现负增长（参阅图 3）。而在交通、建筑、农业和土地利用等占比较小的领域，碳排放的

图3 | 中国碳排放来源以能源与工业为主，自2013年以来已进入平台期

2000-2019年估¹中国温室气体排放量（亿吨二氧化碳当量）



来源：CAIT；世界资源研究所（WRI）；BCG分析。
 1. CAIT数据更新至2016年，2017年及之后数据基于BCG模型测算。尽管无官方统一数据，但普遍公认中国碳排放现今仍处于平台期。

增速也趋缓至 3%左右。全球来看，尽管增速趋缓，但中国依然是世界上碳排放量最大的国家，占全球碳排放比例超过 20%。因此，中国在减碳方面潜力很大。

2.2 为实现碳中和目标，中国须继续加大关键板块的转型力度

中国须在能源、工业、交通、建筑、农业与土地利用五大关键板块加大转型力度，减少碳排放。以实现 1.5°C 路径下的减排目标为基准，建筑和农

图4 | 为实现2060年碳中和目标，中国需加大转型力度.....



业与土地利用板块需要减排幅度最大，在 100%以上。其次是工业板块，减排幅度为 80-85%左右，而能源和交通板块需要的减排幅度在 65-70%左右（参阅图 4）。

为实现碳中和承诺，中国需要沿着 1.5°C 减排路径不懈努力，在各项举措上力争做到极致：

- **能源部门：**更加积极地推动发电侧能源转型，扩大可再生能源（如陆地或离岸风能发电、集中或分布式太阳能发电）的发电比例；在核能发电上持续推进成本节降、安全提升与社会认可；除发电外，加强天然气的补充能源作用的同时逐步淘汰化石燃料；促进 CCS 技术的全面推广与去碳捕获能力提升，将渗透率提升至 90%以上；在能源产品制造的过程中（如炼焦、炼油、采矿）持续探索先进技术和去碳空间。基础设施方面，提高电力系统的灵活性，积极推动特高压技术（UHV）、电化学储能等方面的研究和规模应用；机制方面，努力探索适合于本国国情的碳定价机制，如碳贸易与碳税，以期积极促进能源转型的发展。

工业部门：与能源部门类似，推动清洁能源发电、热电联产以及碳捕获与储存技术的大规模应用，从根本上降低工业自有发电、产热领域的碳排放；在此基础上，在化工、钢铁等产业的工艺流程中持续创新（如钢铁领域的短流程炼钢与节能技术改造、化工领域的甲醇制烯烃技术）并提升设备能效（如先进熔炉、高效电机），以进一步释放去碳潜能。政策方面，积极推动更完善的节能减排标准，并通过经济与税收手段促进能源密集型企业的绿色转型；同时，应利用我国大规模的工业园区基础，推动生态工业园与综合环境治理，释放工业园区在系统性节能减排方面得天独厚的优势。

- **交通部门：**迅猛发展公共交通、乘用车、商用车的电动化，通过提升电池技术和扩张充电基础设施实现新能源车总拥有成本的降低、里程焦虑的消除以及驾驶体验的升级，以持续加强新能源车市场竞争力；针对燃

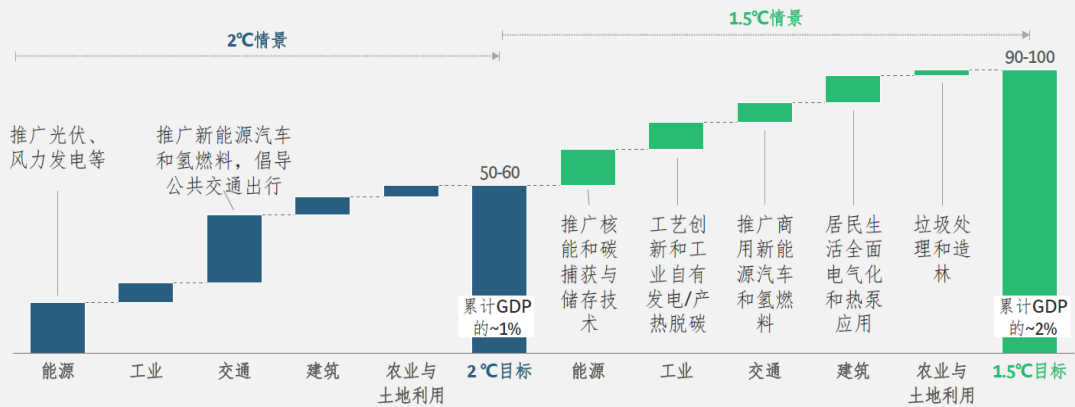
油车，在大规模禁止传统燃油车而仅留下少部分（小于 10%）低油耗车型的同时，提升燃油车能效。同时，加速氢燃料飞机的研发，力争在 2040 年前后实现大规模商业化。

- **建筑部门：**在建筑领域，进一步提升技术和公众认知以加强执行建筑节能改造（如热力管网改造、加强墙体隔热）；在供暖领域，需积极推进热泵的应用拓展，提升在极寒地区亟待解决的供暖效率低下的问题，同时推动取暖的去碳化（如推进电能、工业低品位余热代替燃煤供暖）；太阳能热水器也需突破现今主要应用在远郊地区、价格低廉、质量参差不齐的瓶颈，争取更大的市场渗透率。炊事电气化将是建筑部门节能减排贡献最大、却比较难以实现的举措，需提升公众对电炊具的接受度，并扩大居民建筑电网容量。
- **农业与土地利用部门：**推动生物沼气池规模化发展并逐步提升后市场运维服务的成熟度；化肥的过度利用是农业温室气体（如一氧化二氮）排放的始作俑者，化肥产业革新将有效推动肥料结构的优化，并加速科学施肥方法的普及；在垃圾处理方面，推进垃圾焚烧处理的研发和应用的渗透率，进而破解现有技术与成本方面的难题，取缔对填埋处理方式的依靠，让焚烧处理在城市生活垃圾处理中达到 80% 的水平；持续挖掘碳汇增长的潜力，进一步推进造林与再造林工程，增强温室气体吸收能力，为负排放贡献源源不断的绿色动力。

截至 2050 年，我们预计完成减排目标各项举措所需累计投资为 90-100 万亿人民币，约占 2020-2050 年累计 GDP 的 2%（参阅图 5）。其中，由于技术成熟度等方面的原因，交通部门所需投资最大，主要包括推广新能源汽车

图5 | 在2050年前累计投入90-100万亿人民币

2020-2050年达成2°C和1.5°C目标所需累计投资额和主要投资领域（万亿元）



来源：BCG模型测算。

和氢燃料，倡导公共交通出行。能源部门次之，主要由可再生能源、核能发电以及 CCS 技术的研发与应用拓展驱动。除此以外，工业部门的工艺流程创新、建筑部门的热泵技术、农业与土地利用部门的垃圾焚烧处理也将占据较大的投资份额。

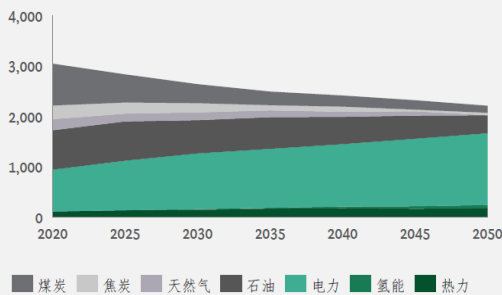
2.3 低碳转型的关键抓手是发展绿色能源与绿色金融

在清洁能源推广方面，中国需要积极在需求与供给两端同时推动清洁能源

图6 | 中国需要积极地在需求与供给两端推动清洁能源的应用

1.5°C情景：终端需求中的化石能源占比须限制在25-30%

终端能源需求(百万吨标准煤)

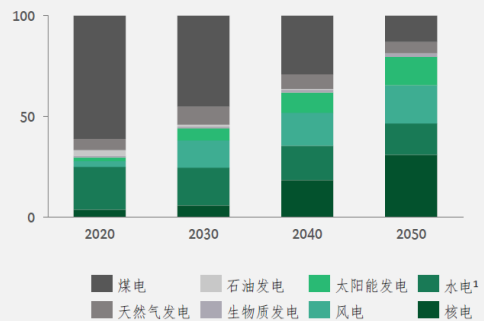


来源：BCG分析。

1. 虽然1.5°C情景的水电比重有所下降，但由于电力需求总体增长，水电发电量的绝对数值仍持续增加。

1.5°C情景：用于发电的化石能源占比应保持在20%以内

发电用能分布(%)

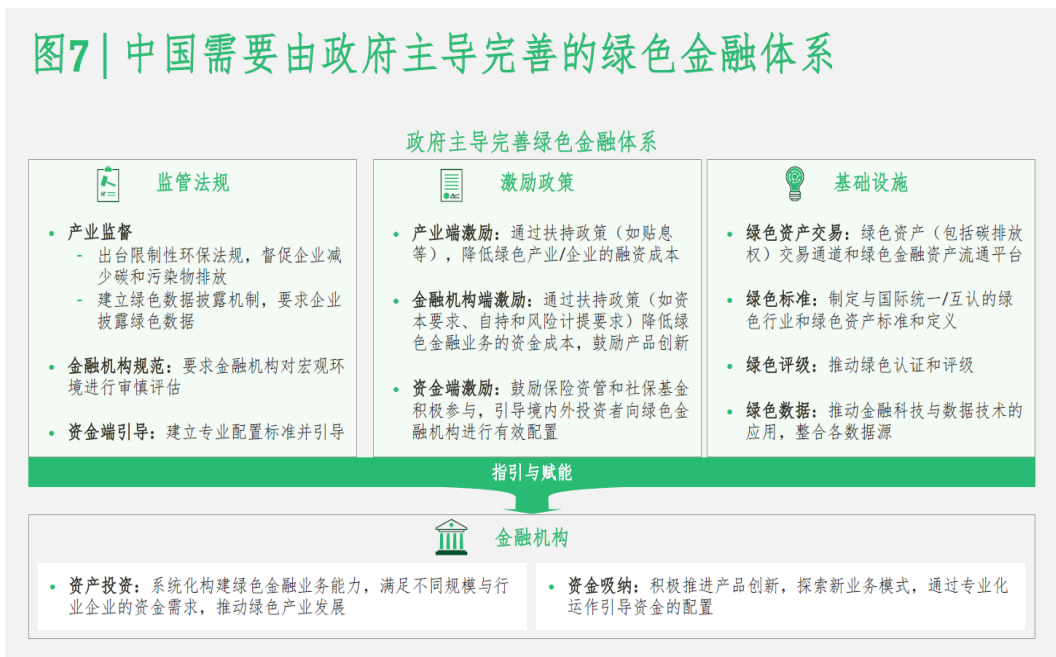


源应用。根据我们的分析，在 1.5°C 路径下，终端需求中的化石能源占比须限制在 25-30% 的比例内；用于发电的化石能源占比应保持在 20% 以内（参阅图 6）。

中国在绿色金融上虽然发展迅速，规模全球领先，但绿色金融生态体系仍有待完善。2019 年，中国 21 家主要银行的绿色贷款余额超过 11 万亿元，大幅领先其他国家。同年，中国贴标绿色债券年发行量超过 3,800 亿元，占全球债券发行总规模的 20%，总量位居全球第一。当前绿色投融资未满足需

求约 4-5 万亿元，仍以每年约 1 万亿元的速度在持续拓宽。然而，由于中国绿色金融标准与国际存在差异，导致国际上认可度欠佳。在 2019 年中国绿色债券发行规模中，不符合国际标准的比例高达 43.9%。为进一步完善中国绿色金融体系（参阅图 7），需要由政府从以下三方面进行主导和推动：

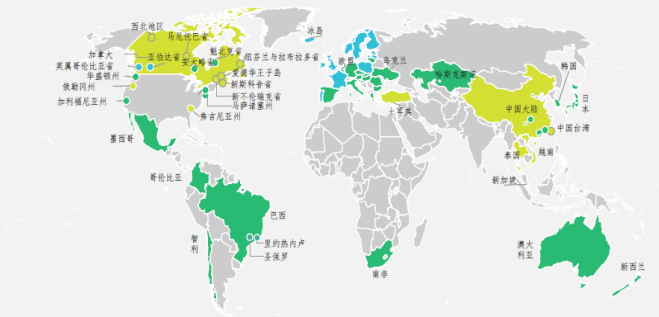
图7 | 中国需要由政府主导完善的绿色金融体系



- 监管法规方面：** 产业端应出台限制性环保法规，督促企业减少碳/污染物排放，并建立披露机制来督促企业披露绿色数据。政府还应对金融机构进行规范，要求其对宏观环境进行审慎评估，同时在资金端建立专业配置标准并进行引导。

图8 | 全球已有67个行政区域制定了碳价格，中国也应积极推行碳交易等绿色资产交易机制

全球已经有67个行政区域以各种形式对碳排放制定了价格



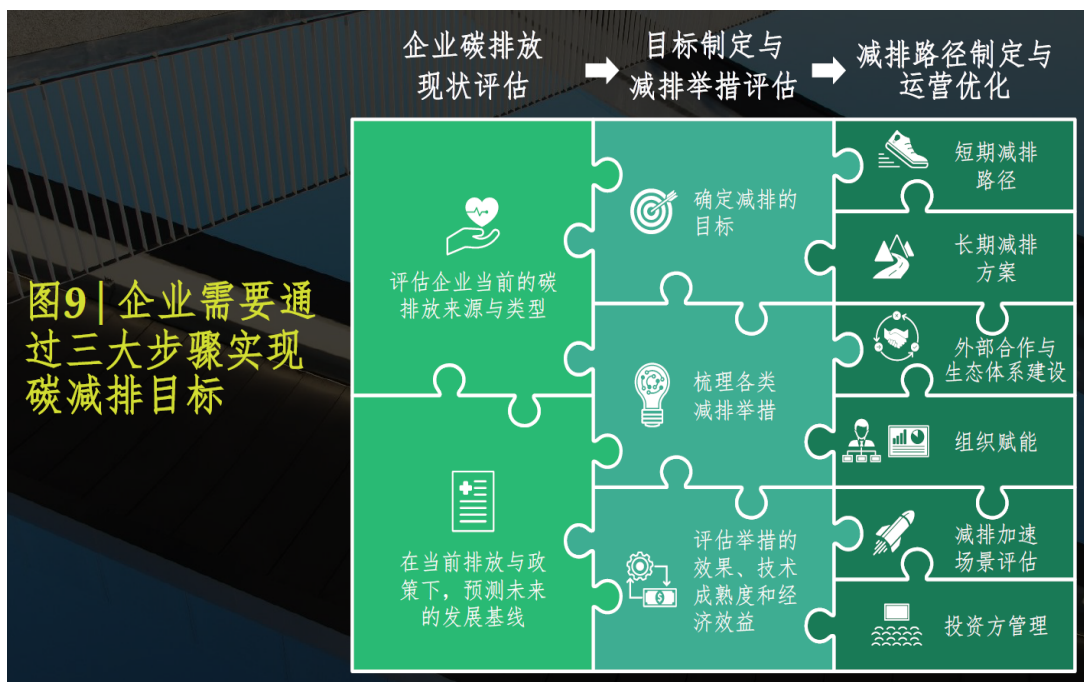
中国也在加强碳排放监管和推动碳交易价格

中国在“十四五”规划中将对碳排放提出更为严格的控制目标

中国已于2013年提出了碳排放交易系统(ETS)的概念,未来计划全国普及和全行业推广

● 已同时实行/计划同时实行碳交易平台和碳税 ● 已实行/计划实行碳交易平台或碳税 ● 交易平台及碳税仍在商讨中
来源：世界银行；BCG分析。
注：圆圈代表国家下属司法管辖区。圆圈大小代表区域大小，即大圆圈指代省/州，小圆圈指代城市。

- 激励政策方面：**对产业端通过贴息等扶持政策降低绿色产业企业的融资成本；对金融机构端通过资本要求、自持和风险计提等扶持政策来降低绿色金融业务的资金成本，鼓励产品创新；对资金端应鼓励保险资管和社保基金积极参与，引导境内外投资者向绿色金融机构进行有效配置。
- 基础设施方面：**制定绿色资产交易通道和绿色金融资产流通平台（参阅图8）；与国际统一/互认绿色行业和绿色资产标准；推动绿色认证和评级以及金融科技与数据技术的应用。



3. 实体企业应抓住减排机遇，制定绿色发展战略并打造可持续供应链

企业是中国绿色经济发展的生力军，它们已经开始先行先试，积极开展绿色探索和实践。我们建议，企业可以通过以下三大步骤来实现更为高远的减碳目标（参阅图 9）：现状评估、目标制定与减排举措评估以及减排路径制定。

3.1 对企业碳排放现状的评估

为了制定减碳路径，企业需要首先评估其当下碳排放量、主要碳排放来源以及能源类型。基线的建立和碳排放根本原因的分析可以助力企业建立合理举措，并支持企业通过与基线的对比，持续衡量举措的有效性。

积极评估碳排放现状对于能源使用的上游和下游企业同等重要。针对能源上游企业，如占全国碳排放 40%的发电企业，首要任务是建立可量化的“基准线”，实现后期对碳排放的监测、报告和核查，并助力企业参与并受益于全国的统一碳市场。能源使用的下游企业，也需要关注其本身生产活动所需的能源结构；同时，因其对自身价值链起到至关重要的引导作用，能源使用的下游企业更需要建立对其自身和其价值链碳排放的全面评估。例如，对于服装品牌，其服装产业链上游的印染技术很大程度上影响碳排放量和生产效率，其运营所需的配送中心、运输和门店都也在不同程度上导致碳排放污染，这些因素都应纳入能源使用下游企业对其碳排放现状的全盘评估中。

3.2 目标指定与减排举措评估

根据 BCG 分析，企业自身的主要减排举措可多达 200 余项（参阅图 10），包括能源结构转型、模式升级、能效提升及碳捕获等。能源结构转型指以可再生能源、核能及生物质能等清洁能源代替煤炭和天然气等化石燃料。举措包括大力发展离岸和在岸风能技术、光伏太阳能以及大坝和川流式发电水能；

挖潜海洋潮汐能和波浪能；以及通过厌氧消化工农、市政、动物废弃物生成沼气等。

图10 | 总共包含了超过200种碳减排举措

BCG碳减排举措数据库包含技术数据、成熟度评估和经济效益数据.....



模式升级要求企业改变现有设备和工艺的运转模式，来推动节能减排，比如采用创新工艺流程以及使用热泵技术等。例如，中国电网企业与研究机构正积极推动电化学储能等方面的研究和规模应用，为发电侧能源转型做好充分准备。在工业部门中，流程创新是推动 1.5°C 减排目标的重要抓手，比如钢铁领域的短流程炼钢与节能技术改造、化工领域的甲醇制烯烃技术作用显著。

能效提升方面，企业应该通过推动工业设备节能、降低燃油车能耗以及推广节能电器等方面的举措来提升能源效率。具体措施包括：推广太阳能热供暖；采取节能的压缩空气生成及应用、通风设备、照明和压缩机等工业设备；通过数字化实现工艺热节省和机械能节省；以及低温余热和吸收式热交换器的热回收。

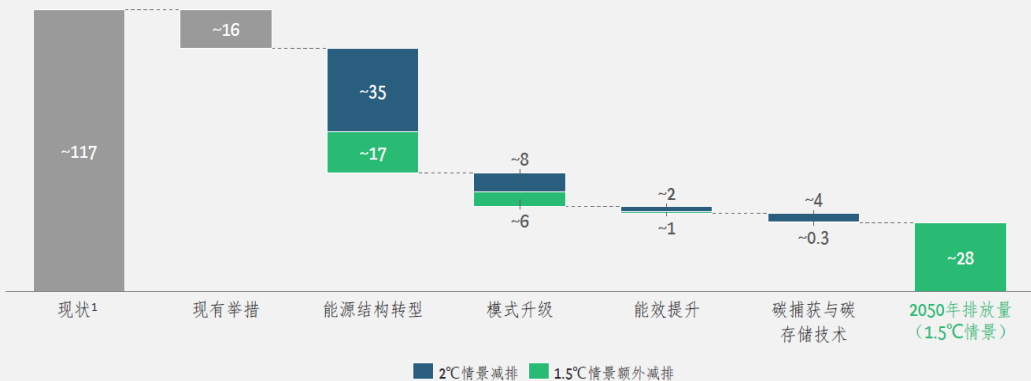
在碳捕获、利用和储存方面，企业在能源和工业领域中使用煤炭、天然气和生物质能源发电时，采用碳捕获与碳储存技术。在碳运输和存储方面，企业可以采用化学链燃烧和氧燃料燃烧，经在岸、离岸和船舶管道运输，采用在岸、离岸和枯竭油气储层存留等措施。在利用捕获到的碳方面，企业可直接将二氧化碳制成干冰，以及当作甲醇、尿素和乙烯等化学品、海藻生物质能以及液化化石燃料的原料。此外，碳纳米管、有机溶剂细菌和炭黑等新兴利用方式也在考虑之列。

3.3 技术推动的能源结构转型是关键

在上述诸多减排举措中，技术推动的能源结构转型是各行各业企业达成减排目标的最关键抓手（参阅图 11）。根据 BCG 模型测算，在 1.5°C 情景下，在上述四大抓手中，能源结构转型所能贡献的额外温室气体减排量居首，高达 52 亿吨二氧化碳当量。其他排序依次是：模式升级（14 亿吨）、能效提升（3 亿吨）和碳捕获、利用及储存（4.3 亿吨）。

图11 | 在这些举措中，技术推动的能源结构转型是企业达成碳减排目标的关键抓手

各抓手贡献的温室气体减排量
(亿吨二氧化碳当量)



来源：BCG模型测算。
1. 2019年。

比如，绿电采购是目前很受关注的能源结构减排举措，企业需要综合考量方案可行性、所需成本与当地政策。目前比较受关注的措施有可再生能源直采计划（DPP）和跨省电力交易，两者成本相对较低，但前者目前只在部分省份中可行，只要企业与可再生电力能源供应商达成一致，即可在省级电力交易中心进行交易；而后者交易须有省级政府主导，需要在两个省之间达成协议，然后交易必须在北京的电力交易中心完成。由于最新国家政策推出了可再生能源配额制（RPS），修改了保证采购量，以及出台互不补贴政策，以促进可再生电力能源的市场交易，未来或将有越来越多的省份采纳DPP政策。

聚焦 DPP 的可再生能源直采方面，购买方须了解下列各利益相关方的关键考量因素，以应对直接采购谈判的复杂挑战。可再生能源购买方关注价格和稳定性，希望可再生电价至少要与基准电价持平，且能保证稳定供应才能满足生产制造需求。可再生能源供给方最关注边际利润，希望出售未被电网采购消纳的电能，来获取发电权并赚取边际利润，以抵消不断增长的调峰成本。电网公司要保证输电安全、负载可控，并提供调峰服务。交易市场负责合规，根据政策审核出具合同并监督价格。地方政府机构要出台法律法规维持可再生能源的供需稳定，同时实现中央政府设立的 RPS、无补贴项目等目标。

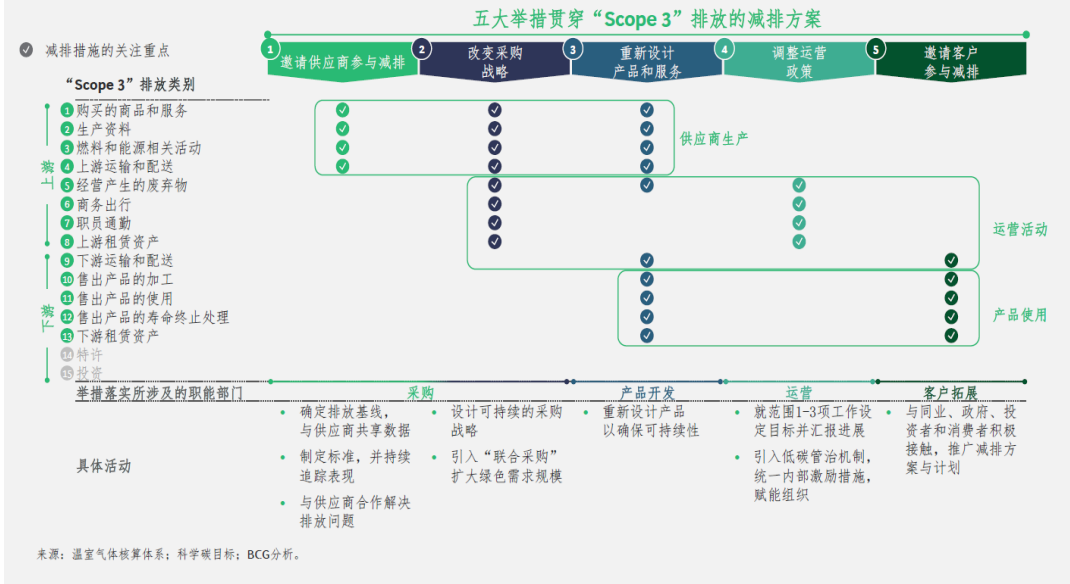
据调查，目前为止，大部分供电企业同意在电网购电价格基础上给出约 2 分钱/千瓦时的优惠。河北、山西、广东均有供电企业愿以低于电网的价格出售可再生电能。以福建的可再生电力直接采购为例，2019 年 12 月可再生电能的平均交易价格为 37.32 分千瓦时，比电网价格低 2 分钱。绿电直购虽然有助于企业降低电力成本并履行环保义务，但是否可行依然高度依赖当地政策。目前该计划可行性主要受两种政策影响：省内可再生电力直接采购市场限额，以及可再生电能优先调度。因此，需要积极推动相关政策制定，加速可再生电能的推广。

3.4 企业打造可持续采购和供应链的五大举措

除了上述减排方面的努力，企业还可以通过梳理供应链上下游各个环节，在供应商、采购、产品服务、运营和管理客户这五大方面来打造可持续的供应链（参阅图 12）：

- **邀请供应商参与减排：**在企业确定了排放基线后，可以与供应商共享减排数据，与供应商合作商讨如何解决排放问题。制定减排标准也要积极让供应商参与其中，并持续追踪减排表现。
- **改变采购战略：**企业应设计可持续的采购战略，并通过引入“联合采购”来扩大对绿色和可再生能源需求的规模。
- **重新设计产品：**产品开发层面，为确保可持续性，企业有必要对某些产品和服务进行重新设计。
- **调整运营政策：**根据上下游中相关运营情况设定目标并汇报进展，引入低碳管治机制，统一企业内部激励措施，来赋能组织减排。
- **邀请客户参与减排：**与行业内伙伴企业、政府、投资者和消费者积极接触，推广减排方案与计划。

图12 | 企业可以通过五大举措打造可持续的供应链



3.5 制定减排成本曲线和完整的绿色发展战略

减排任重道远，绝非一个利益相关方、一套管理班子或一个部门的工作，企业需要综合多方因素，制定减排成本曲线和成本效益高的可行减排路径。制定减排路径须考虑以下主要因素：企业内部包括自身排放基线、减排目标设定、减排技术偏好和可行性等；供应链减排因素包括：上下游排放基线、减排潜力、技术成本、生态伙伴合作意愿以及碳排放属性和责任划分。

此外，通过制定减排成本曲线，企业能识别成本效益最高的可行减排路径（参阅图 13）。

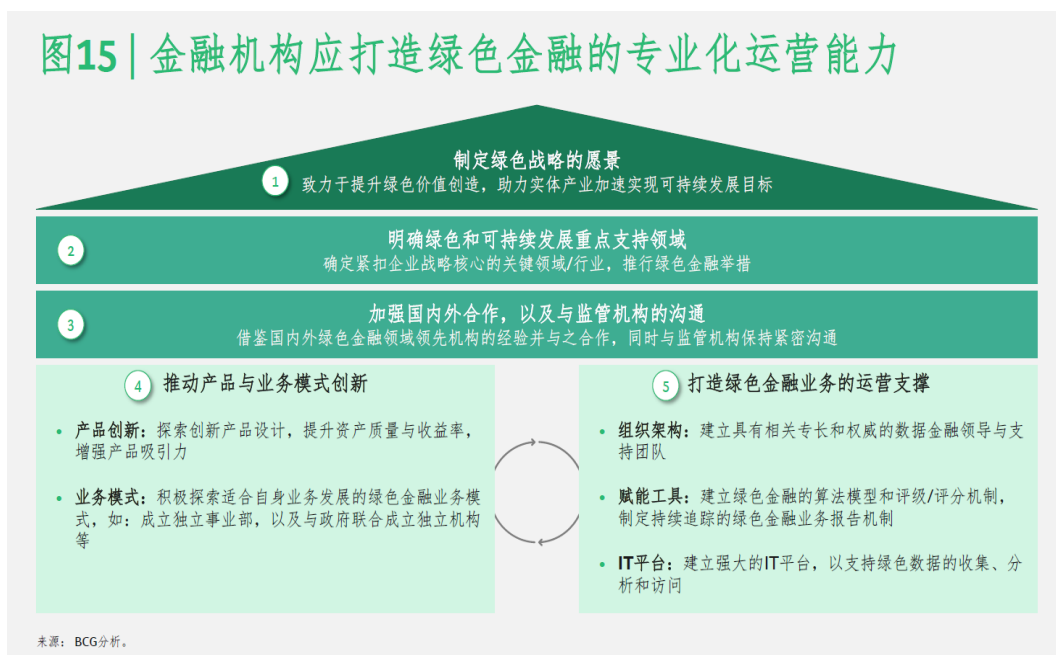
图14 | 企业还需考虑关键支撑与组织赋能，制定完整的绿色发展战略



在组织和管理层面，企业还需考虑设计完整的绿色发展战略，为节能减排提供关键支撑与组织赋能（参阅图 14）。首先，绿色战略离不开组织顶层董事会与 CEO 的强力支持，以及组织赋能。其次，公司要以明确的愿景、可实现的雄心、有凝聚力的阐述以及清晰的商业测算，来设计一系列影响力大且可推广的举措，通过“强强联合”的手段来扩大减排影响。再次，清晰可衡量的目标与追踪机制，就重点与利益相关方积极互动和沟通，以及将碳减排相关问题纳入投资人报告也将成为公司减排事业的关键支撑。

4. 金融机构应建立绿色金融发展能力，通过专业化运营，促进绿色产业发展

作为减排合作中的关键一环，中国的金融机构应全面打造绿色金融的专业化运营能力，致力于提升绿色价值创造，助力实体产业加速实现可持续发展目标，以此为基础实现绿色战略愿景（参阅图 15）。



首先，金融机构要明确绿色和可持续发展的重点支持领域，紧扣企业战略核心，在工业和能源等关键行业领域推行绿色金融举措。中国的金融机构还可以以国际领先政策性金融机构为参照，来进一步明确需要聚焦的投融资决策和金融创新领域。例如，世界银行、欧洲投资银行和绿色气候基金等金

融机构中，偏好程度较高的领域包括可再生能源、低碳交通、健康食物与水安全、可持续城市社区、节能环保、建筑、城市、工业与设备等等。

其次，金融机构可以通过加强国内外合作来借鉴先进经验和举措，并与监管机构保持紧密沟通。

此外，中国的金融机构若想成功践行绿色金融还需要推动产品与业务模式创新，不断探索创新产品设计，提升资产质量与收益率，并增强产品吸引力，同时寻找适合自身业务发展的绿色金融业务模式，如成立绿色金融部和绿色投行等独立事业部门，以及与政府联合成立独立机构等等。德国某银行成立的绿色机构业务银行就是可借鉴的成功例子。该银行以再贷款和再融资等业务为主来支持其他金融机构拓展绿色金融业务，目前已成为推动欧洲绿色金融发展的重要机构，ROE 优于德国商业银行平均水平。

最后，绿色金融业务的壮大离不开相关基础设施和运营的支撑。例如，在组织架构上，需要建立具有相关专长和权威的数据金融领导与支持团队。赋能工具上，可以通过区块链技术实现发行方与投资者直接对接，无需第三方机构参与，利用 AI 等技术实现部分环节自动化来降低人力成本。评级追踪上，可以利用物联网等高新技术建立绿色金融的算法模型和评级/评分机制，制定可测量可追踪的绿色金融业务报告机制，确保资产认证和评级真实可靠。数据收集上，可以通过建立强大的 IT 平台，来支持绿色数据的收集、分析和访问；将绿色数据存储于公用链平台上，提高数据透明度实现有效共享。

总结

科学家一致认为，人类是全球变暖的主要原因，而且这一过程正在以前所未有的速度发生，如不加遏制，我们赖以生存的家园将遭遇灭顶之灾：珊瑚礁濒临灭绝；大部分热带雨林消失；格林兰冰层及北极夏季海冰将融化；数千沿海城市每年将有十个月被洪水席卷……毫不夸张地说，人类已经站在生死存亡的十字路口，各行各业必须背水一战，实现《巴黎协定》的减排目标。

气候变化是我们这个时代最重要的全球性挑战，需要全球范围内乃至社会各界达成共识，采取全面行动，通过合作达成一致的全球温控目标，避免最坏的灾难性结果发生。中国既是碳排放大国，也是绿色能源技术发展和土地绿化的表率。在未来，中国推进可持续战略和减排举措的实施，必将对世界产生重大影响。中国每一个相关部门、企业与个人，都应持续关注低碳减排这一重大课题，在政府、企业和金融机构三方的主导和通力合作下，积极采取行动，为子孙后代守护好这颗蔚蓝星球。

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Building a Greener Future: How China Can Reach Its Dual Climate Goals

BCG

Lars Faeste, Baiping Chen, David He, Bingbing Liu, Shawn Shi

March 2021

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Executive Summary

We stand at a historical turning point. Climate change poses an existential threat to mankind. Without intervention, the global temperature would rise by more than 5°C by the end of the century, food production would be reduced to half of current levels, and 75% of species could be brought to the brink of extinction. As a fast-growing economy and a major global emitter, China has pledged to reach carbon neutrality by 2060 to keep climate change in check. To achieve this goal, China will need to commit to a sustainable development path to keep the global temperature rise to under 1.5°C, or reduce carbon emissions by 75-85% by 2050. In addition to fulfilling its responsibilities as a global superpower, China will boost its sustainable development, stimulate economic growth, and improve its energy security through active climate action.

The Chinese government should play a leading role in global climate efforts and promote the development of green energy and green finance, while accelerating infrastructure building and financial innovation to catalyze the transformation of key sectors. Businesses should also play a part in reducing emissions by developing green growth strategies and building sustainable supply chains. Meanwhile, financial institutions should build green financing capabilities and specialized operations to support green industries.

Most of China's carbon emissions come from energy and industry, and these emissions have remained flat since 2013. To fulfill its net-zero pledge, China must take decisive initiatives under the 1.5°C pathway, accelerating emissions reductions in the sectors of energy, industry, transport, buildings, and agriculture and LULUCF (land use, land use change, and forestry). Following this pathway, China will need to invest RMB90-100 trillion (USD14-15 trillion) on climate initiatives before 2050, equivalent to about 2% of its cumulative GDP from 2020-2050. The largest investments will need to come from the transport sector. Major initiatives should include promotion of new energy vehicle (NEV), synthetic fuels, and public transportation. The energy sector will also require major investments to expand the use of renewable energy, nuclear power generation, and Carbon Capture and Storage (CCS) technology. Meanwhile, process innovation in industry, as well as the use of heat pumps in buildings and waste incineration in the agriculture and LULUCF sectors, will also contribute significantly to emission reduction.

- **Government.** Efforts in the public sector should concentrate on developing green energy and finance. To develop green energy, China needs to accelerate its energy transition on both the supply and demand sides. In green finance, the Chinese government should introduce stricter emissions regulations, provide incentive policies, and build enabling infrastructure.

- **Businesses.** Businesses are the rising force in China’s green economy, and they are already highly active in the green economy. We recommend that companies set more ambitious carbon reduction targets. They should start with assessing the current state, and subsequently set new targets and develop carbon reduction initiatives to meet these targets. Electricity and fuel consumption account for most of carbon emissions from businesses. To reduce their own carbon footprint, businesses have introduced more than 200 measures, including transformation of energy structure, upgrades to business model, improvements in energy efficiency, and capturing of carbon emission. Businesses should take an integrated approach by setting emission reduction curves, designing cost-effective and feasible emission reduction pathways, and enabling their organizations to optimize their green development strategies.
- **Financial institutions.** As key players in emissions reduction efforts, Chinese financial institutions should strive to increase green value creation so that industries can achieve their visions and goals. Financial institutions should strengthen their green financing capabilities by clarifying key support areas, promoting product and business model innovation, and supporting operations.

As a major carbon emitter, China is also a model for green energy technology and green land development. The steps that China takes in the future will undoubtedly

have a remarkable impact on our world. The government, businesses, and individuals must stay wary of climate change and take cohesive action immediately.

1. Climate Action Will Require Concerted Efforts from All Stakeholders

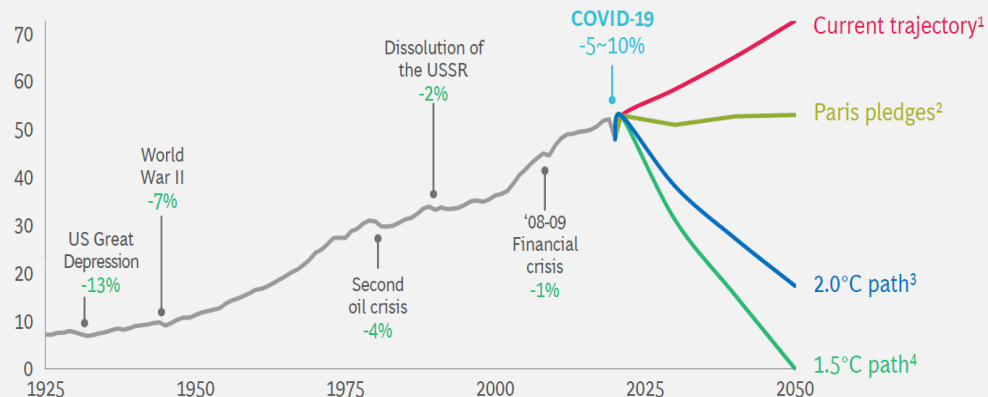
1.1 Mankind's Survival Is Dependent on Controlling Climate Change. However, Not Enough Global Action Has Been Taken Thus Far

In the past few years, the concentration of carbon dioxide in the atmosphere has reached its highest level in 25 million years. In a speech on climate change at the UN headquarters in New York, Secretary-General António Guterres said that climate change has “brought us to an existential crossroad.” Without intervention, global temperatures are expected to rise by 5°C by 2100, an increase that would have a devastating impact: 75% of species are on the verge of extinction and food production could fall by 50%. Throughout history, the famines, migration, and conflicts resulting from food shortages have caused countless wars and even the collapse of whole civilizations.

In the 2015 Paris Agreement, 196 countries committed to keeping the global temperature rise within 2°C. Following this pathway, global actors would make it possible to achieve global net zero by the end of the century. The concentration of carbon in the atmosphere would remain within 430-480 ppm, and the rise in the sea level rise would be kept within 0.6m. However, most of the signatories to the Paris Agreement have not yet taken decisive action.

Exhibit 1 | COVID-19 Resulted in a 5~10% CO₂ Drop, Which Is a Great Opportunity to Accelerate Green Initiatives

Global annual greenhouse gas emissions (billion tons of CO₂ equivalent)



Sources: EDGAR 5.0; FAO; PRIMAP-hist v2.1; Global Carbon Project; IPCC; UNEP Emissions Gap Report; WRI; BCG analysis.
Note: These figures exclude land use, land-use change, and forestry.
1. Assumes GHG emissions grow from 2018 at the same annual rate as the "current policies" scenario in UNEP 2019 Gap report to 2050 (1.1% CAGR).
2. Assumes countries decarbonize at the same annual rate that was required to achieve their intended nationally determined contributions from 2020-2030.
3. Assumes 25% reduction by 2030 and net zero by 2070.
4. Assumes 45% reduction by 2030 and net zero by 2050.

1.2 The COVID-19 Pandemic Was a “Black Swan” Event that Catalyzed New Climate Change Efforts

According to statistics from the European Environment Agency (EEA) and the United Nations Environment Programme (UNEP) (See Exhibit 1), greenhouse gas emissions fell by 5-10% during the pandemic due to the impact of global lockdowns and restrictions, the biggest drop since World War II. Reduction in global carbon emissions is expected to be 2.4 billion tons in 2020, a reduction significantly higher than previous records, such as the 900 million tons at the end of World War II and the 500 million tons at the height of the financial crisis in 2009.

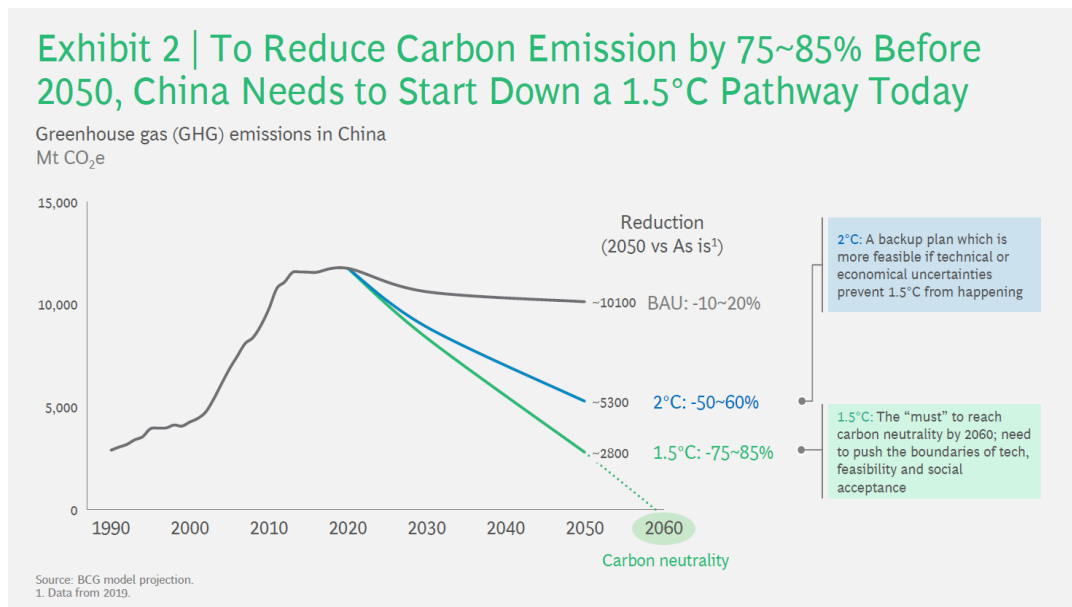
In its 2020 assessment, the Global Carbon Project found that the emission reductions due to COVID-19 were the highest in the US (12%) and the EU (11%). However, due to China's strong economic recovery, its carbon emissions may have only fallen by around 1.7%.

1.3 China Has Acted as a Responsible Superpower in Global Climate Action

In September 2020, in his speech at the 75th United Nations General Assembly, Chinese President Xi Jinping pledged that China's carbon emissions would peak by 2030 and the country would reach carbon neutrality by 2060. Mankind can no longer afford to ignore the repeated warnings of nature. Concerted international efforts are necessary to bring about a green economic recovery in the post-pandemic world. China's commitment to reach carbon neutrality by 2060 is closely aligned with the 1.5°C target set in the Paris Agreement.

President Xi's pledge also reflects China's long-term vision for collective global climate action and the country's unflinching determination in investing in this vision. Our analysis shows that in order to achieve net zero by 2060, China needs to take immediate action, go beyond the 1.5°C target, and work towards a 75-85% greenhouse gas (GHG) reduction by 2050. (See Exhibit 2.) The country must

invest significantly more than planned under the current carbon reduction



approach, continue to push the boundaries of technologies, and increase public awareness of climate issues.

1.4 Taking Active Steps to Reduce Emissions Would Benefit China in Three Aspects

In addition to fulfilling its responsibilities as a global superpower, China will boost its sustainable development, stimulate economic growth, and improve its energy security through active climate action. Under the 2°C pathway, China would need to reduce its emissions by 50-60%, whereas under the 1.5°C pathway, it would need to achieve a 75-85% reduction.

- **Sustainable development.** Committing to a higher GHG reduction target would help China avoid potential natural disasters in the future and improve the living conditions for its people. Conversely, not taking stricter measures could cause frequent natural disasters, diseases, and resource shortages. For example, heat waves in China could last up to 10 times longer by 2050, reaching 12 days a year. In addition, floods in China's economically developed and densely populated areas and coastal cities could cause GDP losses of RMB2 trillion by 2050.
- **Direct economic boost.** The development of the green economy could directly boost China's GDP and employment in the medium and long term. According to our calculations, under the 1.5°C pathway, green technology investments would account for more than 2-3% of China's GDP by 2050. In addition, according to the International Renewable Energy Agency (IRENA), even under the 2°C scenario, green industries such as renewable energy, green construction and transport would boost China's employment by about 0.3%.
- **National energy security.** Developing renewable energies and green technologies such as wind and solar power would significantly reduce China's dependence on imported and non-renewable energy sources while increasing its energy security. China is currently one of the world's biggest investors in wind and solar power and holds a third of the world's renewable

energy patents. According to our calculations, China could reduce its fossil energy demand by around 80% by 2050 under the 1.5°C pathway.

1.5 The Government, Businesses and Financial Institutions Must Unite to Achieve China's Climate Goals

First, the Chinese government clearly sees developing the green economy and green technology as high priorities. The “14th Five-Year Plan” emphasized the development of green industries and the transformation of energy, industry, and other key sectors. To further decarbonize, China should actively reform its energy structure and develop a green finance system to attract private capital investments and stimulate green industries.

Second, despite the difficulties they currently face, businesses should work with the government to continue the positive trend that started during the COVID-19 pandemic and make a “green recovery.” High-emitting businesses, such as electricity and heat generation companies, should accelerate their green energy transformation, while businesses in other sectors should leverage government incentives to go green. Responding to the “Made in China 2025” policies, companies should build environmentally friendly supply chains, starting from upstream suppliers. Furthermore, they should introduce resource-saving and environmentally friendly practices in their procurement, production, marketing,

recycling, and logistics systems, and establish extended producer responsibility (EPR) systems.

Third, in terms of green finance, financial institutions should offer services to facilitate investment, funding, operations, and risk management in industries such as environmental protection, energy saving, clean energy, green transportation, and buildings. They should establish systematic green finance strategies and increase resource allocations for green projects. In addition, they should support transformations and upgrades in green industries, environmentally friendly advanced manufacturing, service industries, and emerging industries by improving their service offering. Financial institutions should develop innovative green financing models and boost industry development by offering green credit, bonds, stocks, and development funds.

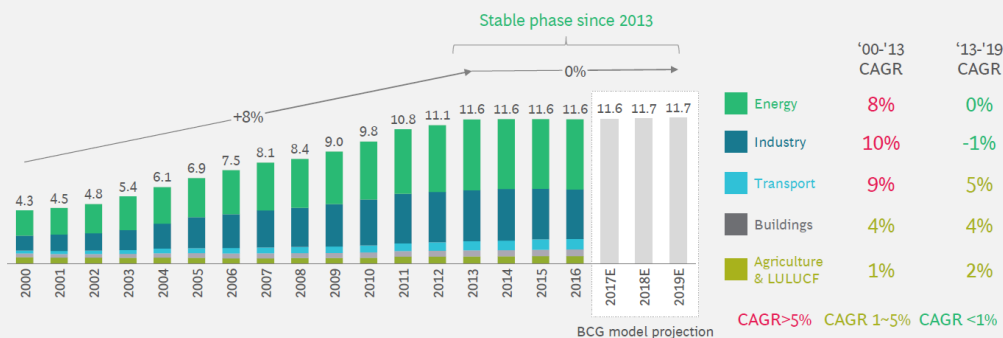
2. The Chinese Government Should Push Green Energy and Finance to Help Transform Key Industries

2.1 The Majority of China’s Carbon Emission Comes from Energy and Industry, but Emissions Have Plateaued Since 2013

In the last 20 years, we have witnessed not only China’s rapid economic development, but also its rise as a major emitter. Before 2013, annual growth in China’s carbon emissions had for a long time remained at around 8%. After 2013, as China’s economic growth slowed, and it introduced more energy saving and emissions reduction measures, its carbon emissions started to plateau. China’s greenhouse gas (GHG) emissions mainly come from five sectors: energy, industry, transport, buildings, agriculture and LULUCF. Of these sectors, energy and industry account for the largest share — more than 80% of China’s total. After

Exhibit 3 | China’s Emissions Mainly Come from Energy and Industry, but Have Stabilized Since 2013

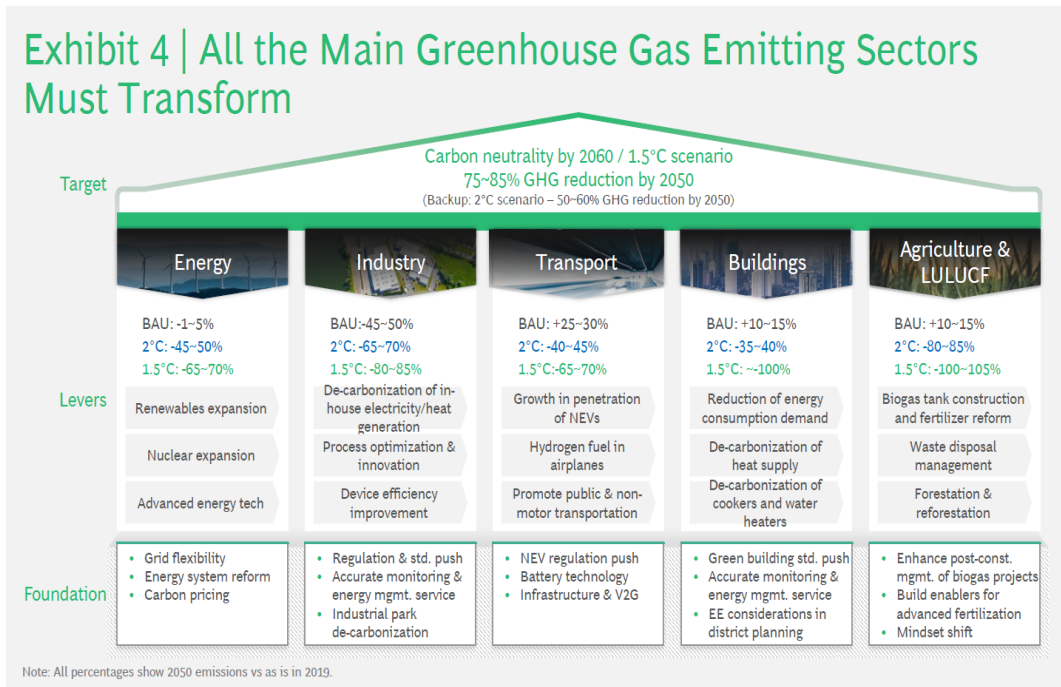
China GHG emissions 2000-2019E¹ (Gt CO₂e)



Sources: CAIT, World Resources Institute (WRI), BCG analysis.
 1. The data up to 2016 is from CAIT, data of 2017 and beyond is projected by BCG model. Although there is no official census, the common view is that China's emissions will remain stable for the moment.

2013, growth of carbon emissions in these two sectors has remained flat, and we have even seen negative growth. (See Exhibit 3.) In addition, in transport, buildings, agriculture and LULUCF, which account for a much smaller share, growth of carbon emissions has also slowed, reaching around 3%. Despite the global economic slowdown, China is still the world’s largest GHG producer,

Exhibit 4 | All the Main Greenhouse Gas Emitting Sectors Must Transform



accounting for more than 20% of global carbon emissions. Therefore, China still has the potential to reduce its carbon footprint and make a remarkable impact on the world.

2.2 To Reach Net Zero, China Must Transform Key Industries Rapidly

China must step up its efforts to transform the energy, industry, transport, buildings, and agriculture and LULUCF sectors to keep up with its climate targets. Based on the 1.5°C pathway, the buildings and agriculture and LULUCF sectors would need to take the strictest measures, to achieve cuts of emissions of more than 100%. The next largest reduction would need to be in industry, which is required to reduce emissions by about 80-85%, while a 65-70% reduction would be necessary in the energy and transport sectors. (See Exhibit 4.)

China needs to take immediate action and push for the more ambitious 1.5°C target to fulfill its pledge to reach net zero:

- **Energy.** Achieving required reduction means a major transition to the use of renewable energy, such as onshore or offshore wind power, centralized or decentralized solar power. For nuclear power to gain popularity, further cost reduction, safety measures, and societal acceptance are all crucial factors. Besides electricity generation, the energy sector should gradually phase out fossil fuels and replace them with natural gas. It will also be necessary to explore decarbonization in energy product manufacturing (including coking,

oil refining and mining processes), broaden the adoption and efficacy of CCS technology, and pursue CCS penetration of more than 90%. Enabling infrastructure requires grid flexibility and both further research and scalable application of technologies such as ultra-high voltage (UHV) and electrochemical energy storage. Lastly, facilitating energy transition demands localized enabling mechanisms for carbon pricing, such as carbon trading and carbon tax.

- **Industry.** As with the energy sector, the industry also needs to promote clean power and adaption of combined heat and power (CHP) and CCS technology at scale. In addition, unlocking further decarbonization potential demands innovation in the process flow of chemical and steel industries (such as short-process steelmaking and energy-saving technologies in the steel industry and methanol-to-olefin (MTO) process in the chemical industry) and upgrade to more efficient equipment (such as advanced furnaces and high-efficiency motors). In terms of policy, the government should consider promoting more comprehensive emissions-reduction standards and create economic and tax incentives for energy-intensive industries to go green. Meanwhile, the sector should leverage China's large-scale industrial parks to develop eco-industrial parks and holistic environmental governance, unleashing the potential for industrial parks to reduce emission in a systematic manner.

- **Transport.** Reducing carbon emission in transportation demands the rapid electrification of public transport as well as passenger and commercial vehicles. Achieving this target requires stronger battery technology and scaling of charging infrastructure that allow for decreased total cost of ownership, reduced range anxiety, and improved driving experience, all factors making NEVs more attractive. The last mile will involve phasing out internal combustion engine vehicles on a large scale, leaving only a small number of fuel-efficient vehicles (less than 10%) while enhancing the efficiency of the remaining traditional vehicles. Moreover, it will also be necessary to encourage the technology development of hydrogen-powered aircrafts, targeting wide-scale commercialization by 2040.
- **Buildings.** Further enhancing technology and raising public awareness are important to promote energy efficiency innovation in buildings (such as improvement to the heating pipe network and wall insulation). To reduce emission from heat supply, key levers are investment in heat pump expansion, improvement in heating system efficiency especially in cold regions, and decarbonization in energy usage (such as increasing the use of electricity and heat from industrial low-grade waste instead of coal). In addition, breakthroughs in solar water heater industry are necessary to achieve greater market penetration and overcome the challenges of limited market reach and low and inconsistent quality. Complete carbon neutrality also requires electrification of cooking appliances, a measure that is effective yet

challenging, and its implementation demands enhanced grid capability and wide public acceptance.

- **Agriculture and LULUCF.** The sector ought to scale up biogas projects and strength its service capability. Furthermore, excessive use of fertilizer is a key contributor to agricultural greenhouse gas emissions (e.g. nitrous oxide). Innovation in fertilizer will optimize its utilization and accelerate the popularization of scientific methods for fertilizer application. In waste management, the sector needs to advance research and development of waste incineration treatment to solve technological and high-cost challenges, ultimately reducing landfill of waste and incinerating over 80% of waste. To go the last mile, the sector must continue to explore the potential of carbon sinks in carbon removal through afforestation and reforestation.

We estimate that China will need to invest RMB90-100 trillion (USD14-15 trillion) on climate measures before 2050, equivalent to about 2% of its cumulative GDP from 2020-2050. (See Exhibit 5.) The largest investments will need to come from the transport sector. Major initiatives should include promotion of NEV, synthetic fuels, and public transportation. The energy sector will also require major investments to expand the use of renewable energy, nuclear power generation, and CCS technology. Meanwhile, process innovation in industry, as well as the use of heat pumps in buildings and waste incineration in

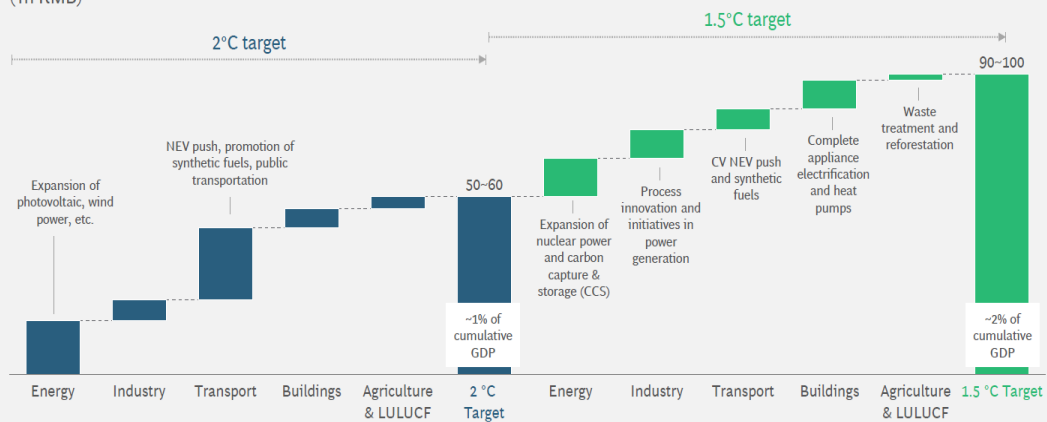
the agriculture and LULUCF sectors, will also contribute significantly to emission reduction.

2.3 Powering the Green Transformation: Renewables and Green Finance

Renewables. China needs to roll out the adoption of clean energy in both the energy mix and electric power generation. Our analysis indicates that to stay on

Exhibit 5 | Cumulative Investment Through 2050 Will Be RMB 90 to 100 Trillion

Cumulative investment and main investment areas from 2020-2050 under 2°C and 1.5°C targets (Tn RMB)



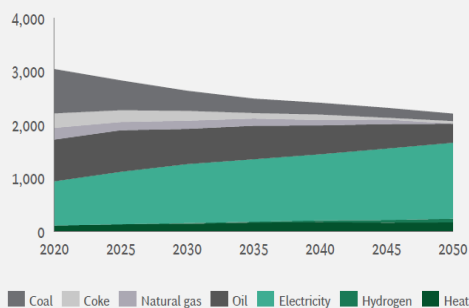
Source: BCG analysis.
Note: NEV=New energy vehicles; CV=Commercial vehicles.

the 1.5°C pathway, fossil fuels must be limited to within 25-30% of China’s final

Exhibit 6 | China Needs to Roll Out Clean Energy in both Demand and Supply Sides

1.5°C: Fossil energy = 25-30% final energy demand

Final energy demand (Mt Ce)

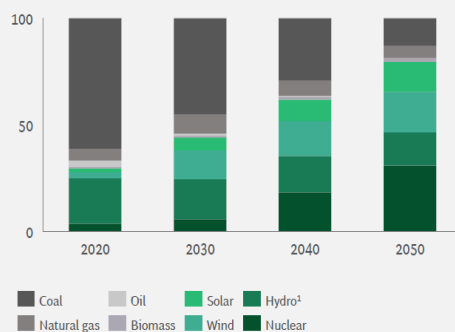


Source: BCG analysis.

1. Although the share of hydro power decreases in the 1.5°C target, the absolute amount of power generation is increasing due to overall increase in demand.

1.5°C: Fossil energy = ~20% of electric power generation

Distribution of electric power generation (%)



energy demand, and to within 20% of electric power generation. (See Exhibit 6.)

Green finance. Although China’s green finance is developing rapidly and leads the world in terms of scale, there are structural deficiencies. In 2019, 21 of China’s major banks had more than RMB11 trillion (USD1.7 trillion) in green loans outstanding, far more than other countries. In the same year, over RMB380 billion (USD58 billion) in green bonds was issued in China, accounting for over 20% of the global total issued that year and the largest of any individual country. There is still another RMB4-5 trillion (USD0.6-0.8 trillion) in unmet green financing and investment demand, and this continues to grow at approximately

RMB1 trillion (USD0.15 trillion) every year. However, differences between Chinese and global green finance standards have meant that some international investors have avoided Chinese green bonds. In 2019, 43.9% of China-issued green bonds were not compliant with global standards. If China is to create an ecosystem for green finance (See Exhibit 7), the government needs to take the initiative and pull the following levers.

- **Regulation.** Regulators need to roll out restrictive environmental regulations that encourage corporations to cut carbon emissions and pollution and establish disclosure mechanisms to encourage corporations to release green data. The government must also require financial institutions to scrutinize the macro environment while establishing professional capital allocation standards and providing guidance to capital providers.
- **Incentive policies.** The government can leverage supportive policies (e.g. interest subsidies) to reduce the cost of financing for green industries/corporations. Financial Institutions can leverage supportive policies (e.g. capital requirements, self-holding and risk provision requirements) to reduce green finance capital costs and encourage product innovation. The government should encourage market participation from insurance companies, asset managers, and social security funds; in addition, the government needs to effectively guide Chinese and overseas investors in their capital allocation for green finance.

- Infrastructure.** The government should establish a green asset trading channel and green finance asset circulation platform. (See Exhibit 8.) It should develop globally aligned and recognized green industry, asset standards, and definitions; roll out green certification and green ratings; and scale up the adoption of FinTech and digital technology.

Exhibit 7 | The Chinese Government Needs to Develop an Ecosystem for Green Finance

A government-led & optimized green finance system

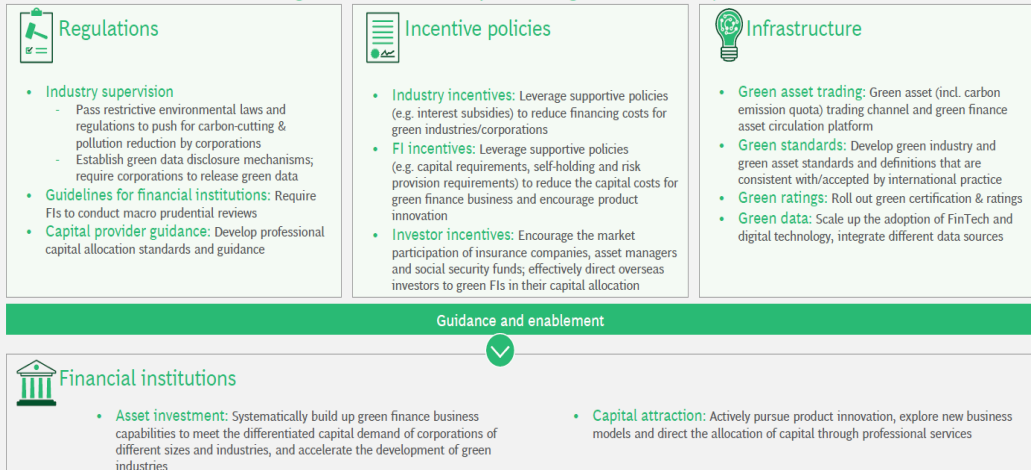
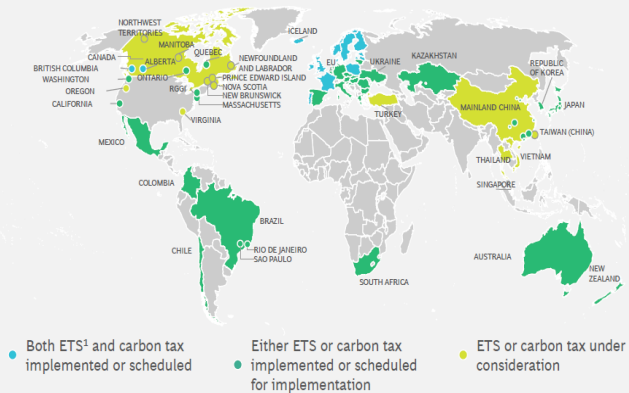


Exhibit 8 | 67 Jurisdictions Are Putting a Price on Carbon and China Is also Building a Platform

67 Jurisdictions are putting a price on carbon in different forms

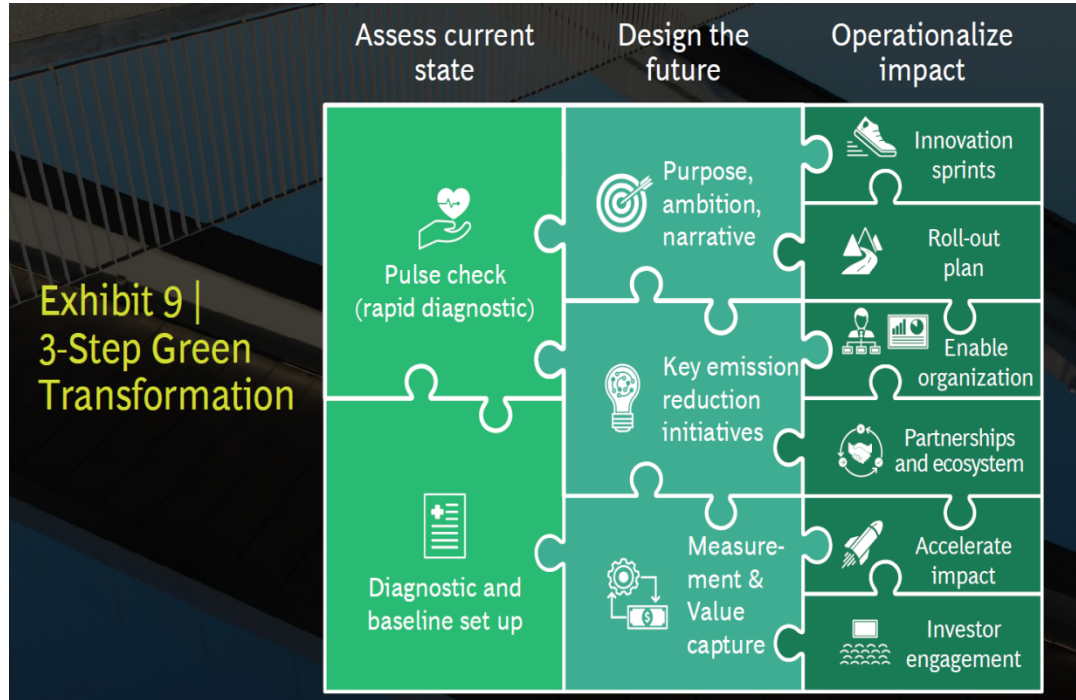
China is strengthening carbon regulation and building ETS



China will publish stricter regulations on carbon emissions in its “14th Five-Year Plan”

China proposed the ETS concept in 2013, and plans to develop & roll out in the future

3. Seizing Opportunities with Green Development Strategies and Sustainable Supply Chains



Businesses are the central pillar of China’s green economic development. They have begun their own pioneering experiments to explore a greener path forward. We suggest that corporations take three steps to reach more ambitious emissions reduction targets (See Exhibit 9): assess the current emissions state, design the future, and operationalize impact.

3.1 Assess the Current Emissions State

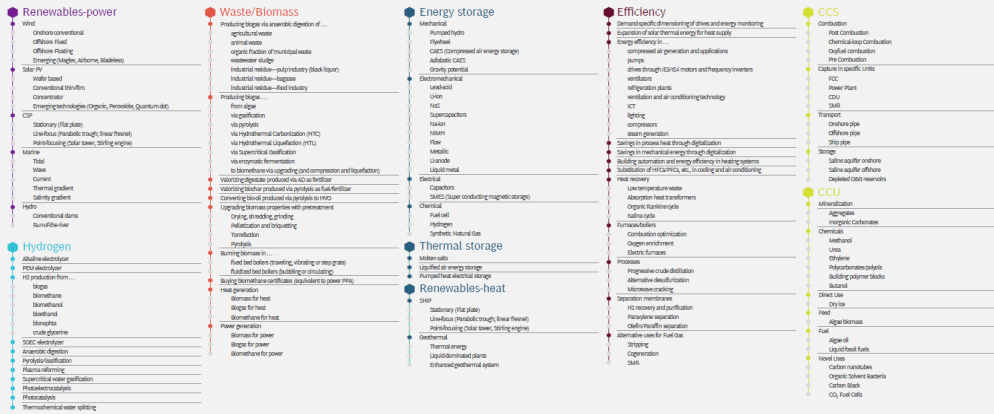
Developing pathways for decarbonization requires companies to first assess their current carbon emissions, main sources of emission, and types of energy consumed. Establishment of baseline and analysis of the root causes for carbon emissions are fundamental to the creation of sound initiatives and evaluation of the initiatives.

Assessing the current state of carbon emissions is equally important for companies in both upstream and downstream of energy usage. For upstream companies, such as electricity generation companies that account for 40% of the country's carbon emissions, the primary task is to establish quantifiable "baselines" for the monitoring, reporting, and verification of carbon reduction, which set of capabilities also enable companies to participate in the national carbon emissions trading market. For downstream companies, assessing their own energy structure and usage is important. Meanwhile, as these downstream companies often play vital roles in guiding their respective value chains, comprehensively assessing the carbon footprint throughout the value chain is crucial and necessary. For instance, in the apparel industry, its upstream dyeing and printing processes have high carbon footprint. Furthermore, the industry's operations from distribution, transportation, to physical stores all generate carbon emissions to varying degrees. All these factors need to be considered when

Exhibit 10 | Database with ~200 Vetted Emission Initiatives

Database includes technical data, maturity assessment, economics ...

Illustration



Source: BCG

assessing the current emission state of companies in the downstream of energy usage.

3.2 Design the Future

BCG analysis has identified over 200 emission reduction initiatives that businesses can take (See Exhibit 10), including changing energy sources, improving operation efficiency, improving energy efficiency, and capturing carbon. Transformation of the energy structure means supplanting fossil fuels such as coal and natural gas with clean energy sources such as renewables, nuclear, or biomass. Companies need to invest heavily in offshore and onshore wind energy, photovoltaic energy, conventional dam, and run-of-the-river hydro energy; leverage the potential of marine (tidal, wave, and current) energy; and

produce biogas via anaerobic digestion of agricultural, municipal and animal waste.

To improve operation efficiency, companies need to change how their devices and processes run in order to drive energy efficiency and emissions reductions, such as via innovating in transportation, designing new industrial processes, and applying heat pumps. Companies in China's power grid and research institutions have been researching application at scale of ultra-high voltage technology (UHV) and electrochemical energy storage. Process innovation will be an important lever in industry and could include shortening the steel-making process and integrating energy-saving technology, or integrating the methanol-to-olefin (MTO) process in chemical engineering.

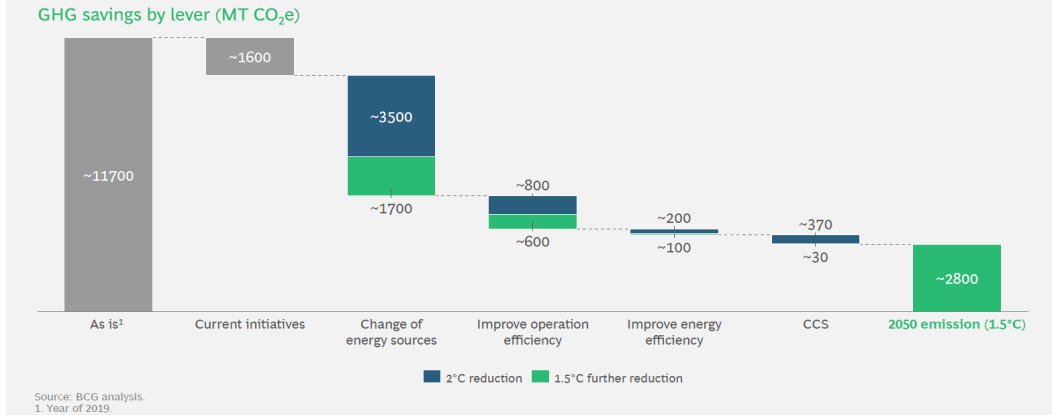
Businesses will need to focus on specific needs and monitor energy use, improve industrial machinery efficiency, improve the fuel efficiency of inefficient combustion engines (ICEs), and promote energy-efficient appliances. Concrete initiatives businesses can take include adoption of solar energy heaters and energy-efficient compressors, ventilation devices, lighting, and other industrial devices. Businesses can also leverage digitalization to make heat and mechanical energy efficiency gains in industrial processes and recover heat via low temperature waste and absorption heat transformers.

Companies can leverage carbon capture, utilization, and storage (CCUS) technology to capture and store carbon emissions during coal, natural gas, or biomass power generation. Furthermore, businesses can transport carbon using chemical-loop combustion and oxyfuel combustion, using onshore, offshore and ship pipes, while leveraging onshore, offshore, and depleted oil and gas reservoirs for storage. Businesses can directly use captured carbon to make dry ice or use as a raw material for the production of chemicals such as methanol, urea, and ethylene, biomass energy, and liquid fossil fuel. Other novel uses could include carbon nanotubes, organic solvent bacteria, and carbon black.

3.3 Tech-driven Energy Mix Transformation is Key

Transformation of tech-driven energy sources is the most important lever for businesses across the board. (See Exhibit 11.) BCG's model projects that, under the 1.5 °C pathway, a change in energy sources that would deliver the greatest drop in excess GHG emissions, as much as 1.7B tons CO₂-equivalent, compared to improving operation efficiency (600M tons), energy efficiency improvements (100M tons), and CCUS (30M tons).

Exhibit 11 | Among All Levers, Technologies that Enable a Change in Energy Sources Are the Most Crucial



For example, green power procurement is now a focus for many companies, but businesses will need to consider feasibility, costs, and local policies. Direct power purchases (DPPs) and inter-province power exchanges are both relatively cheap, but DPPs are only recognized in some provinces. If a business can reach an agreement with a renewable energy provider, it may make deals at the provincial-level power exchange. Inter-province power exchanges, on the other hand, must be led by the provincial government, and require an agreement between two provincial governments. The final deal must then be registered at the national power exchange in Beijing. China recently launched its renewable portfolio standard (RPS) policy, modified the existing purchase quotas, and enacted subsidy-free pricing to spur market trading of power. In the future, more Chinese provinces may adopt DPP policies.

For DPPs, buyers need to understand and consider multiple factors before coming to the negotiation table. Buyers will be preoccupied with energy prices and price stability and will expect the price of renewable energy to remain at least at the base price level. The government will need to ensure energy stability to protect production and manufacturing demand. Renewable generators are particularly margin-sensitive, and they will hope to sell energy not purchased by the national grid in order to gain generation rights and offset growing peak-shifting costs. Grid companies need to ensure safe transmission, control loads, and provide peak-shifting services. The trading market is responsible for compliance, producing contracts, and monitoring prices as required by policy. Local government agencies need to roll out laws and regulations to ensure the stable supply of renewable energy, while meeting RPS and subsidy-free objectives set by the central government.

BCG research shows that most electricity providers would agree to giving a discount of RMB0.2 (USD0.03) per kilowatt-hour on sales to the national grid. Power companies in Hebei, Shanxi, and Guangdong provinces have all expressed willingness to sell electricity at below national grid price. For example, the average renewable electricity transaction price on DPP agreements in Fujian in December 2019 was RMB0.37 (USD0.06) per kilowatt-hour, or RMB0.2 (USD0.03) lower than the national grid price. Although direct purchasing of green electricity would help businesses to lower their electricity costs and fulfill their

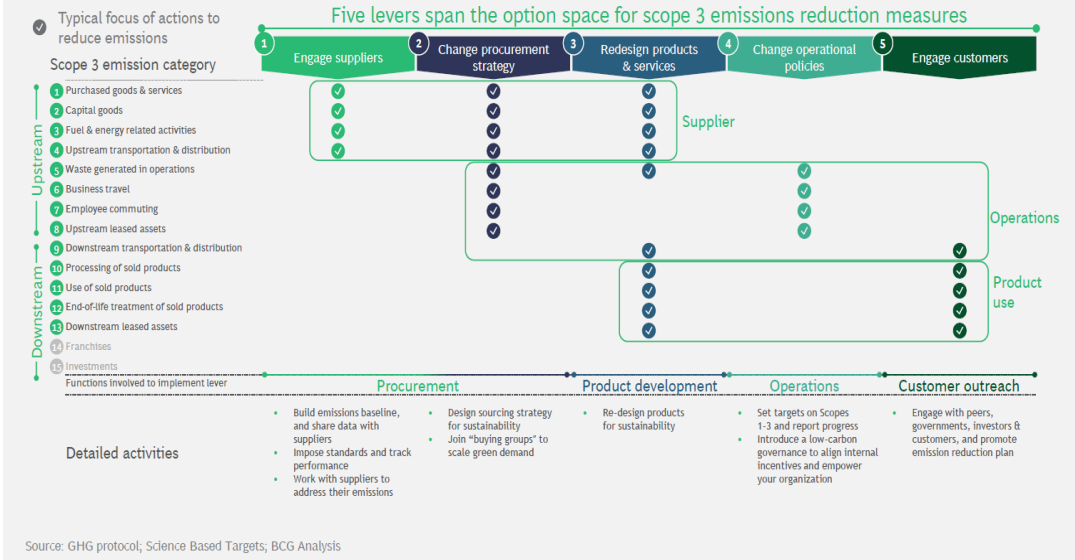
environmental obligations, the feasibility in practice depends largely on local governments. Currently, the plan is affected by two policies: the quotas on direct purchases of renewable electricity within a province, and preferential dispatching for renewable electricity.

3.4 Five Levers to Build Sustainable Procurement and Supply Chains

In addition to the initiatives mentioned above, businesses can also build more sustainable supply chains through five levers: suppliers, procurement, products & services, operational policies, and customer engagement. (See Exhibit 12.)

- First, businesses can engage their suppliers to help reduce their emissions by setting an emissions baseline, sharing data, and working with them to reduce emissions. Businesses can impose standards for emissions reductions, but suppliers need to be fully engaged, and performance needs to be tracked.
- Second, businesses need to design sustainable procurement strategies, and they can join “buying groups” to scale green demand.
- Third, businesses need to look at which of their offerings need redesign to ensure sustainability.

Exhibit 12 | Corporates Can Take Five Levers to Build a Sustainable Supply Chain



- Fourth, businesses can also change their operational policies, set targets for upstream and downstream operations and report progress, and introduce low-carbon governance to align internal incentives and empower the organization.
- Finally, businesses can engage with peers, government, investors, and customers on emissions reduction plans.

3.5 Define an Abatement Curve and a Comprehensive Green Development Strategy

Emissions reduction is a serious and challenging task, the responsibility for which goes far beyond a single stakeholder, management group, or sector. Businesses need to look at the bigger picture, set an abatement curve, and set an emissions reduction path that is both cost-effective and feasible. Businesses need to consider the following internal factors: emissions inventory and baseline scenario analysis, the attitude towards emissions reduction and target setting, and technology scouting and feasibility assessment. They should also consider supply chain factors such as the emission inventory and baseline in the value chain, CO₂ reduction potential, abatement technology cost, willingness of ecosystem partners to participate, nature of carbon emission, and the division of responsibility in emissions reduction.

Furthermore, by defining an abatement curve, companies can better identify the most cost-effective and feasible path to emission reductions. (See Exhibit 13.)

Exhibit 13 | Corporates Need to Develop a Cost-efficient and Feasible Path Considering Sets of Factors

Key factors to build emission reduction path

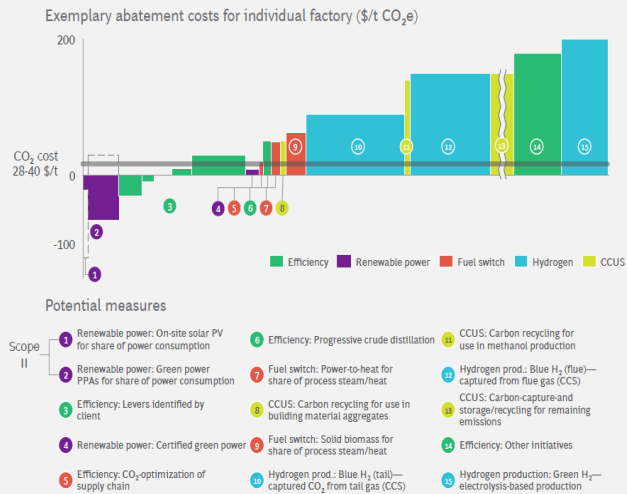
Scope 1 & 2 factors (own company)

- Emissions inventory and baseline scenario analysis
- Target setting
- Preference for emission reduction technologies
- Technology scouting
- Technology feasibility
- Technology cost
- Emission reduction potential

Scope 3 factors (supply chain)

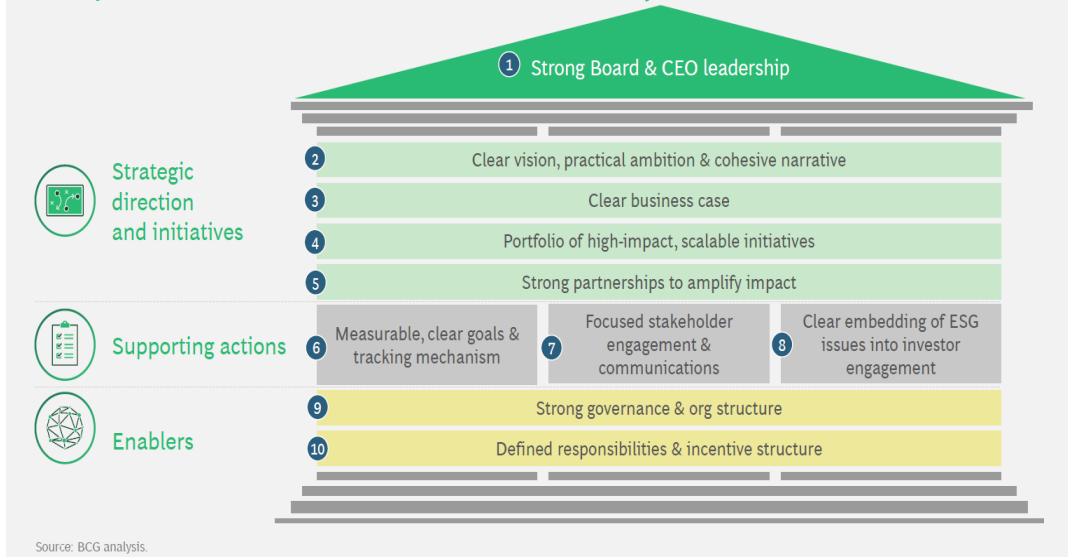
- Value chain emission inventory and baseline
- Emission reduction
- Technology cost
- Willingness of ecosystem partners
- Supply chain engagement initiatives and steering model

Abatement curve helps to identify the most cost-efficient and feasible path to emission reduction for the company



Businesses also need to design better green development strategies that can support emissions reductions and empower organizations. (See Exhibit 14.) First, boards of directors and CEOs need to get behind green development strategies by providing strong corporate governance and organizational structures, defining responsibilities, and setting up an incentive structure. Second, companies need a clear vision, practical ambition, and a cohesive narrative. Green development strategies need to be backed by a strong business case and high-impact, scalable initiatives. Finally, businesses need to forge strong partnerships to amplify the impact of their strategies. Setting up measurable, clear goals and a tracking mechanism, managing effective engagement with stakeholders, and clearly

Exhibit 14 | To Develop a Comprehensive Green Strategy, Corporates also Need to Consider Key Enablers



embedding ESG issues into investor engagement are all key supporting actions that underpin a green strategy.

4. Financial Institutions Must Develop Green Finance Capabilities

Exhibit 15 | Financial Institutions Need to Develop Capabilities in Green Finance



Source: BCG analysis.

As an integral player in reducing emissions, China’s financial institutions need to develop their green finance capabilities across the board, improve their green value creation, and accelerate progress toward the sustainable development goals for the real economy as a means to realize their green strategy vision. (See Exhibit 15.)

First, financial institutions need to identify key areas to drive green and sustainable development. Companies can identify key sectors, such as industry or energy, to implement green finance initiatives in line with their strategic focus. China's financial institutions can also look to leading international policy financial institutions' practices to guide their own investment, financing decision-making, and financial innovation. For example, global financial institutions including the World Bank, European Investment Bank, and Green Climate Fund are giving greater priority to funding for renewables, low-carbon transport, healthy food and water security, sustainable urban communities, and environmental buildings, cities, and industrial machinery.

Second, financial institutions can collaborate with partners in China and around the world to leverage the best practices and initiatives, while remaining in close contact with regulators.

Success in green finance, however, requires China's financial institutions to innovate on their products and business models. They need to redesign their offerings and enhance asset quality and yields to give their offerings greater appeal. Meanwhile, they need to find the business model that best suits their individual circumstances, such as setting up an independent business unit like a green finance department or investment bank, or establishing an independent institution jointly with the government. One practice that Chinese financial institutions could learn from is experience of a German bank, which set up a green institutional business bank. The subsidiary bank focuses on re-lending and

refinancing services, helping other financial institutions expand their green business. This bank has now become a major contributor to the development of green finance in Europe, with an ROE higher than the average of German commercial banks.

Finally, to flourish, green finance requires the support of infrastructure and operations. For instance, financial institutions need to build up professional and authoritative data finance leadership and support teams. Financial institutions can use blockchain tech to directly connect issuers and investors, cutting out the middleman. They can also build up their algorithm capabilities to automate some processes and reduce labor costs. The Internet of Things and other new technologies can support algorithm models and appraisal mechanisms for green finance, delivering a continuous tracking mechanism to ensure the reliability and authenticity of asset certification and ratings. Financial institutions need to establish a robust IT platform to enable better green data collection, analysis, and access.

Conclusion

It is the consensus of the scientific community that climate change is a chiefly man-made phenomenon. Furthermore, climate change is accelerating at an unprecedented speed. If it is not slowed, our living environment will be destroyed; coral reefs face extermination; the vast majority of the world's tropical rain forests will disappear; the Greenland ice sheet and summer Arctic ice will melt; and thousands of coastal cities will be swept by flooding for ten months of the year. We are at a crossroads: If we do not make a stand and act to fulfill the commitments of the Paris Agreement, we face oblivion.

Climate change is the most important global challenge of our time. It mandates a global, society-wide consensus and comprehensive action. By working together to meet our temperature control targets globally, we can avoid disaster. As a major carbon emitter, China is also a model for green energy technology and green land development. The sustainable development strategies and emission reductions measures China takes in the future will undoubtedly have a major impact on the world. Reducing emissions needs to be on the agenda of every government department, business, and individual in China. The government, businesses, and financial institutions can set an example and act cohesively to leave a greener planet for future generations.

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