绿色发展：“十四五”回顾与“十五五”展望

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摘　要：本文系统梳理和阐释了在习近平生态文明思想科学指引下，中国“十四五”时期绿色发展取得的历史性成就及其对“十五五”时期的战略启示。文章认为，“十四五”期间，中国成功突破了环境库兹涅茨曲线所预设的“先污染、后治理”的传统路径，通过能源结构清洁化跨越式发展、生态环境质量根本性改善、绿色生产力体系性崛起、环境治理能力现代化升级以及全球生态贡献引领性增强等多维度成就，实现了经济增长与资源环境消耗的初步“脱钩”，为全球可持续发展贡献了中国智慧。面向“十五五”这一实现碳达峰目标的关键攻坚期，文章构建了一个以深化“碳排放双控”制度创新为保障、以强化“绿智韧”融合新质生产力为核心引擎、以拓展引领性全球协作为支撑的系统性实施框架，旨在为推动经济社会发展全面绿色转型、绘就人与自然和谐共生的中国式现代化新画卷提供理论与实践路径参考。

关键词：绿色发展；全面绿色转型；“十四五”；“十五五”；新质生产力
JEL 分类号：O13；Q56；Q58

一、引言

在全球经济发展理论史上，环境库兹涅茨曲线长期占据主导地位。这一经典理论认为，环境退化与人均收入存在非线性关系，即在较低收入阶段环境压力通常随经济增长加剧，而在较高收入阶段，伴随技术进步、产业结构调整及环境规制强化，部分污染指标可能转为下降，从而呈现倒U型轨迹（Grossman & Krueger，1991）。这种理论预设了“先污染、后治理”的发展路径，成为许多发达国家工业化道路的理论注脚，也导致许多以西方现代化为模式的发展中国家误认为现代化等同于西方化，未能在发展经济的同时走出一条经济发展与生态环境保护双赢的道路。

习近平生态文明思想作为习近平新时代中国特色社会主义思想的重要组成部分，构建了系统完整的生态文明理论体系。这一思想以“人与自然和谐共生”为核心理念，以“绿水青山就是金山银山”为基本内核，以“良好的生态环境是最普惠的民生福祉”为价值取向，以“山水林田湖草沙是生命共同体”为系统思维，以“用最严格制度最严密法治保护生态环境”为法治保障，形成了逻辑严密、内涵丰富的理论框架。其理论创新在于实现了三个超越：一是超越

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了西方环境经济学将生态保护视为经济负担的狭隘视角，将生态环境保护定位为高质量发展的内在要求；二是超越了传统发展经济学将经济增长与环境保护对立的理论预设，揭示了二者的辩证统一关系；三是超越了局部治理的碎片化思维，形成了系统性、整体性、协同性的生态文明治理观。正是这种理论上的彻底性，使得中国能够在全国范围内推动一场深刻的绿色革命。

新时代的中国，正是在习近平生态文明思想指引下，突破了传统工业化理论的线性演进模式，通过建设人与自然和谐共生的中国式现代化的伟大实践，依托跨越式发展、创新驱动和系统思维的多重逻辑重构，走出了一条全新的绿色发展道路。“十四五”时期，中国展现了工业化、信息化、城镇化、农业现代化与绿色化的“五化同步”的发展奇迹。通过“并联式”发展避免了重蹈“串联式”发展的道路。更重要的是，中国坚持“保护生态环境就是保护生产力，改善生态环境就是发展生产力”的绿色生产力观，将绿色发展纳入经济增长函数的核心位置，实现了从要素驱动到创新驱动的根本转变。因此，相较于主要关注资本、劳动投入与技术进步但忽视生态约束的传统新古典增长理论基准设定而言，中国的新发展理念强调以“创新”和“绿色发展”为导向，通过推进绿色技术创新和完善生态环境治理体系，显著提高了经济增长中的绿色含量，实现了经济增长与资源消耗、环境污染的逐步相对“脱钩”。

不单如此，“绿水青山就是金山银山”理念在“十四五”时期的全面实践，标志着中国生态文明理论实现了质的飞跃，更深层次的实践价值在于中国通过“两山论”建立了生态价值转化机制。各地探索建立的“生态银行”搭建了资源变资产的桥梁（秦涛等，2025），“碳普惠”机制激励了全民践行绿色生活[①]，一系列关于生态产品价值实现的制度创新在中华大地深化落地。这些探索系统性地将清新的空气、洁净的水源、美丽的风景这些曾经的“无价之宝”量化、转化、市场化，让守护“好风景”的各方获得实实在在的“回报”，从而为绿色产业注入了源源不断的内生动力。

从全球视野看，“十四五”时期，中国成功举办《生物多样性公约》第十五次缔约方大会（COP15），推动达成“昆明－蒙特利尔全球生物多样性框架”，为全球生物多样性保护提供了中国方案[②]。中国提出的人类命运共同体理念超越狭隘的民族国家利益，为南南合作、南北对话提供了新思路。近年来，中国的绿色发展已经从多个维度为全球环境治理提供了丰富的有益启示和重要补充，为全球环境治理机制提供了新的思路与借鉴（郇庆治，2025）。例如，中国的大规模国土绿化行动为全球应对气候变化提供了重要路径，贡献了全球新增绿化面积的

① 资料来源：上海市生态环境局，《上海市碳普惠管理办法》，2025年10月30日，https://www.shanghai.gov.cn/gwk/search/content/5c8129b3a2b340ad8a05947183c22587。

② 资料来源：新华社，“习近平主席在《生物多样性公约》第十五次缔约方大会领导人峰会上的主旨讲话解读”，2021年10月13日，https://www.gov.cn/xinwen/2021-10/13/content_5642189.htm。

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四分之一，成为全球“增绿”最多最快的国家。这些实践成果证明，中国绿色发展模式具有可复制、可推广的价值。

基于这一系列深刻的理论创新与丰富的实践探索，本文梳理了在习近平生态文明思想科学指引下“十四五”时期中国绿色发展所取得的全方位、开创性成就，总结了所积累的经验与启示。立足新的历史起点，面向“十五五”这一基本实现社会主义现代化夯实基础的关键时期，要以党的二十届四中全会作出的战略部署为指引，以推动经济社会发展全面绿色转型为纽带，以“绿、智、韧”深度融合为核心，聚焦“双碳”目标牵引，在构建新型能源体系、培育新质生产力、优化国土空间格局、创新政策保障机制以及深化全球环境治理合作等关键领域实现战略性、体系性突破，从而为全面绘就人与自然和谐共生的中国式现代化崭新画卷奠定更为坚实的绿色根基。

二、“十四五”时期绿色发展的历史性成就

“十四五”时期，中国秉持“绿水青山就是金山银山”的理念，将生态文明建设置于治国理政的突出位置，推动经济社会发展与生态环境保护协同共进，实现了从重点打好污染防治攻坚战向全面推进美丽中国建设的跨越式转变。这一时期，中国沿着党的二十大所确立的降碳、减污、扩绿、增长协同推进的路径，通过中央生态环境保护督察等制度利器压实“党政同责、一岗双责”，使绿色成为高质量发展的鲜明底色，绿色发展成为高质量发展不可动摇的基本逻辑和全社会共同的价值追求。

（一）主要成就

一是在能源革命方面，清洁低碳转型实现跨越式发展，能源安全得到极大巩固。能源领域作为主战场，在“十四五”时期取得了突破性进展和历史性成就。中国构建了全球最大、发展最快的可再生能源体系，可再生能源发电装机占比由“十三五”末的约40%跃升至60%左右[③]，风电、光伏年新增装机容量连破亿千瓦台阶，发展速度与规模前所未有。2024年，可再生能源发电装机规模历史性超过煤电，标志着电力供应结构发生根本性转折。能源消费“含绿量”显著提升，非化石能源消费占比从2020年的15.9%提高到2024年的19.8%，每年稳定提升约1个百分点，超额完成了“十四五”规划拟定目标[④]。尤为重要的是，能源转型在保障安全的前提下稳健推进。“十四五”前四年，国内能源生产有力支撑了消费增量90%以上的自主保障，其中近一半的新增发电量来自新能源。全社会用电量中，每3度电就有1度来自绿色电力，而全球

③ 资料来源：国家能源局，“国家能源局举行新闻发布会 介绍前三季度可再生能源并网运行情况”，2025年10月31日，https://www.nea.gov.cn/20251031/7be6728f6d8a48a4955a24a45013b37f/c.html。

④ 资料来源：国家能源局，“逐绿向新‘十四五’时期能源转型‘加速跑’”，2025年10月31日，https://www.nea.gov.cn/20251017/293d07cfb51f483eab7e7ab0b279b343/c.html。

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一半以上的新能源汽车行驶在中国，生动诠释了“能源饭碗”端得更牢、更绿。与此同时，科技创新支撑有力，新能源专利数占全球四成以上，光伏转换效率、海上风电单机容量、新型储能装机规模等多项指标领跑全球，为转型提供了硬核驱动力[⑤]。

二是在环境质量改善方面，污染防治攻坚战取得历史性、系统性成果，人民获得感显著提升。“十四五”时期，污染防治攻坚战向纵深推进，环境质量改善成效凸显，人民群众生态环境满意度连续上升。其一，在大气环境方面，全国地级及以上城市细颗粒物（PM2.5）平均浓度从2020年的35微克/立方米降至2024年的29.3微克/立方米，下降16.3%；空气质量优良天数比例达到87.2%，重污染天气大幅减少，蓝天白云已成常态。其二，重点区域治理效果显著，京津冀及周边地区、汾渭平原PM2.5浓度较2020年分别下降18%和20%。其三，在水环境方面，地表水优良（1－3类）水质断面比例首次突破90%，达到90.4%，长江、黄河干流水质稳定保持Ⅱ类，地级及以上城市黑臭水体基本消除，水清岸绿的景象日益普遍。其四，在土壤环境方面，污染风险得到有效管控，受污染耕地安全利用率稳定在90%以上，重点建设用地安全利用得到有效保障，守住了人居环境安全底线[⑥]。

三是在生态修复方面，国土空间格局系统优化。“十四五”时期，我国生态修复与国土空间格局优化实现了从量变到质变、从局部到全局、从应对到前瞻的历史性飞跃。其一，国家确立了以国土空间规划为基础、以用途管制为手段的“多规合一”管理体系，终结了长期以来各类规划“九龙治水”、空间冲突的局面。通过科学评估与精准划定，将超过30%的陆域国土面积纳入生态保护红线，使之成为不可逾越的“高压线”[⑦]。这一举措是对国土空间功能进行的结构性优化，它明确了生产、生活、生态空间的边界，为核心生态功能区、生态环境敏感脆弱区构筑了永久性的“安全岛”，为自然生态的自我恢复与长期演替提供了坚实保障。其二，以国家公园为主体的自然保护地体系建设加快推进，首次在制度上实现了对最重要自然遗产的整体保护和系统管理，标志着我国自然生态保护进入了国家认同、法律保障的新阶段[⑧]。其三，生态安全屏障更加稳固。以“三区四带”（青藏高原生态屏障区、黄河重点生态区、长江重点生态区、东北森林带、北方防沙带、南方丘陵山地带、海岸带）为核心的全国重要生态系统保护和修复重大工程总体布局基本形成，国家生态安全屏障骨架构筑得更加牢固[⑨]。总之，通

⑤ 资料来源：央视网，“全球最大、发展最快、世界领先！见证我国能源高质量发展多个‘第一’”，2025 年8月26日，https://news.cctv.com/2025/08/26/ARTIRdW8JSyhgc2BZ3THuGSL250826.shtml。

⑥ 资料来源：中国人大网，“国务院关于2024年度环境状况和环境保护目标完成情况的报告”，2025年4月28日，http://www.npc.gov.cn/c2/c30834/202504/t20250428_444977.html。

⑦ 资料来源：央视网，“生态保护红线制度展现大国担当 筑牢‘三区四带’国家生态安全屏障”，2023年8月15日，https://news.cctv.com/2023/08/15/ARTIwgomjIfud0wsiV9lyMgd230815.shtml。

⑧ 资料来源：中国人大网，《中华人民共和国国家公园法》，2025年9月24日，http://www.npc.gov.cn/npc/c2/c30834/202509/t20250912_447755.html。

⑨ 资料来源：中国发展改革报社，“决胜‘十四五’七张图的故事 从一张图看如何守住大国生态安全”，2025年10月30日，https://www.ndrc.gov.cn/wsdwhfz/202510/t20251030_1401268.html。

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过国土空间格局的系统优化与生态的系统性修复，我国历史性地扭转了生态退化趋势，构建起了面向未来的绿色发展空间框架，为中华民族永续发展和建设美丽地球家园奠定了坚实的生态根基。

四是在绿色生产力方面，产业结构实现深度调整，新增长引擎实现历史性飞跃。“十四五”期间，中国以高水平生态环境保护推动新质生产力发展，经济增长的“含金量”与“含绿量”同步提升。其一，单位国内生产总值能耗累计降低11.6%，相当于减少二氧化碳排放约11亿吨，能效提升速度位居全球主要经济体前列。其二，产业结构优化调整效果显著，全国“两高”（高排放、高污染）项目环评审批数量持续下降，而风电、新能源汽车等高技术、绿色项目环评数量大幅增长，2025年上半年同比增幅分别达44.4%和31.3%⑩。其三，绿色制造体系加速构建，根据工信部2025年9月发布的新闻，国家级绿色工厂数量增至6430家⑪。绿色低碳产业异军突起，成为外贸新动能。2024年以电动汽车、锂电池、光伏产品为代表的“新三样”出口额较2020年增长2.6倍，中国为全球提供了超过70%的光伏组件和60%的风电装备⑫。我国新能源汽车2024年产量突破1300万辆，产销量连续十年保持全球第一，彰显了绿色技术创新的强大驱动力和产业竞争力⑬。

五是在治理现代化方面，监管能力实现智慧转型，市场机制有效构建。“十四五”时期，中国生态环境治理体系与治理能力现代化水平显著提升。其一，中国建成了全球规模最大、要素最齐全的生态环境监测网络，涵盖3.3万个监测站点，并应用无人机、AI声纹识别、“黑灯实验室”等技术，实现了采样、分析全过程自动化与智能化，监测效率与精准度大幅提高⑭。智慧执法体系深刻改变了监管模式，通过构建“天、地、空、水、陆、海”一体化问题发现机制，利用卫星遥感、红外成像等技术推行非现场、无感式监管，使得2025年1—8月现场执法检查次数下降30%的同时，问题发现率反而提升了10—25个百分点，累计推动26万多个环境问题整改⑮。其二，市场机制建设取得里程碑式突破，全国碳排放权交易市场作为全球覆盖温室气体排放量最大的碳市场，已实现平稳运行。截至2025年12月31日，全国碳排放权交易市场配额累计成交量8.65亿吨，累计成交额576.63亿元。同时，自愿减排项目及减排量登记工作扎实开展，截

⑩ 资料来源：国务院新闻办，“国务院新闻办举行‘高质量完成“十四五”规划’系列主题发布会 介绍‘十四五’时期经济社会发展成就”，2025年7月9日，https://www.gov.cn/lianbo/fabu/202507/content_7031379.htm。

⑪ 资料来源：中国工信新闻网，“工信部：我国累计培育国家绿色工厂6430家、绿色工业园区491个”，2025年9月9日，https://www.cnii.com.cn/yw/202509/t20250909_683782.html。

⑫ 资料来源：新华社，“碳达峰碳中和的中国行动”，2025年11月8日，https://www.gov.cn/zhengce/202511/content_7047492.htm。

⑬ 资料来源：新华社，“我国新能源汽车产销量连续10年保持全球第一”，2025年9月9日，https://www.gov.cn/yaowen/liebiao/202509/content_7039823.htm。

⑭ 资料来源：光明网，“无人机采样、黑灯实验室…… 中国生态监测进入2.0智能时代”，2025年9月19日，https://kepu.gmw.cn/eco/2025-09/19/content_38297532.htm。

⑮ 资料来源：蒋晓平，“生态环境部：‘十四五’期间推动整改各类环境问题26万余个”，2025年9月19日，https://news.cnr.cn/native/gd/20250919/t20250919_527368311.shtml。

中国知网 https://www.cnki.net

至2025年12月底，已登记自愿减排项目33个，减排量1776.37万吨[16]。

六是在全球贡献方面，中国以坚定的行动和开放的姿态，成为全球生态文明建设的重要参与者、贡献者和引领者。“十四五”时期，中国郑重提出碳达峰碳中和目标，并构建了“1+N”政策体系，将承诺转化为扎实行动。其一，可再生能源装机规模已提前实现2030年国家自主贡献目标，为全球应对气候变化注入了强劲动力。通过产品出口，中国在“十四五”期间为其他国家和地区减少碳排放约41亿吨[17]。其二，在国际合作方面，中国不仅积极推动气候变化多边进程，还通过深化绿色“一带一路”建设、启动“昆明基金”支持发展中国家生物多样性保护等方式，广泛开展南南合作。其三，如前文所述，中国在电动载人汽车、锂离子蓄电池、太阳能电池等绿色技术领域的创新与制造优势，为全球提供了优质、普惠的绿色产品与服务，丰富了全球绿色供给，以实际行动诠释了“共建清洁美丽世界”的责任担当。

（二）宝贵经验和基本启示

“十四五”时期中国绿色发展之路，是一条将生态文明建设融入经济建设、政治建设、文化建设、社会建设各方面和全过程的系统性变革之路，是一条以生态优先、绿色发展为导向的高质量发展新路。“十四五”时期的绿色发展成就，不仅以靓丽的数据为“十五五”转型奠定了物质基础，更以其探索的宝贵经验，为“全面绿色转型”的战略实施提供了方法论启示。

一是在物质基础方面，一系列指标性成就构筑了转型的坚实平台。其一，能源领域，可再生能源装机占比大幅提升，新能源汽车产销量连续十年全球第一，这为构建新型能源体系、推动交通绿色革命提供了强大的产业和技术支撑。其二，环境质量方面，PM2.5浓度显著下降，江河水质根本性好转，表明大规模、高强度治理的技术路径和政策组合是行之有效的。其三，生态保护方面，森林覆盖率持续提高，生态保护红线全面划定，为“扩绿”和维系生态安全屏障提供了空间保障。这些成就证明，我国已经具备了在发展中解决环境问题、以绿色变革催生新增长点的强大能力。

二是在经验启示方面，“十四五”实践为“全面”转型提供了关键指引。其一，制度创新是根本保障。从中央生态环保督察压实地方责任，到全国碳市场以市场化手段推动减排，显示出最严格的制度、最严密的法治是突破转型阻力的关键。其二，科技创新是核心动力。绿色低碳产业成为外贸新动能，凸显了科技创新对培育新质生产力、塑造国际竞争新优势的决定性作用。其三，系统观念是基本方法。“协同推进降碳、减污、扩绿、增长”理念在部分领域的成功实践，验证了多目标协同治理路径的可行性，为“十五五”时期在更大范围、更深层次协同推

⑯ 资料来源：高敬，“2025年全国碳市场平稳有序运行”，2026年1月1日，https://www.news.cn/fortune/20260101/f1a3e548d93c4fc7bcf00efc409daaed/c.html。

⑰ 资料来源：中国政府网，《碳达峰碳中和的中国行动》，2025年11月8日，https://www.gov.cn/zhengce/202511/content_7047492.htm。

中国知网 https://www.cnki.net

进指明了方向。这些从实践中得来的启示，是指导“全面绿色转型”不可或缺的宝贵财富。

这些成就与经验，为“十五五”时期乃至更长远未来，建成美丽中国和实现人与自然和谐共生的现代化奠定了坚实基础，也已然为人类社会的可持续发展贡献了更为厚重的中国力量。

三、基于“十五五”规划建议的中国绿色发展战略特征

党的二十大报告明确指出，“推动经济社会发展绿色化、低碳化是实现高质量发展的关键环节”，这从本质上界定了绿色与发展的关系。党的二十届四中全会通过的《中共中央关于制定国民经济和社会发展第十五个五年规划的建议》（下文简称《建议》）将“加快经济社会发展全面绿色转型，建设美丽中国”确立为“十五五”时期的重大战略任务与目标。这一战略部署，特别是其所内含的“全面”二字，标志着“十五五”时期中国的生态文明建设有望实现从重点领域攻坚、试点工程推进到经济社会发展方式系统性、深层次变革的历史性跨越。

（一）经济社会发展全面绿色转型深刻的理论内涵

首先，是覆盖领域的“全面性”。它超越了将绿色转型局限于能源、工业等生产部门的传统认知，要求将其贯穿于经济、政治、文化、社会建设的各方面和全过程。这意味着转型不仅涉及产业结构、能源结构的调整，更涵盖了空间格局、生产方式、生活方式乃至价值观念的全方位变革。例如，《建议》不仅部署建设新型能源体系，也强调要完善绿色消费激励机制，形成绿色生活方式，体现了对经济社会发展全链条、各环节的系统性重塑。

其次，是治理路径的“系统性”。全会强调“以碳达峰碳中和为牵引，协同推进降碳、减污、扩绿、增长”，这揭示了“全面绿色转型”内在的协同逻辑。它不再是单一目标的线性治理，而是将应对气候变化（降碳）、改善环境质量（减污）、提升生态承载力（扩绿）和保持经济活力（增长）这四个目标视为一个有机整体，通过系统规划与政策协同，实现多重环境效益与经济效益的共赢（周宏春，2025）。这要求必须摒弃“就碳论碳”“就污染治污染”的碎片化思维，转向更加注重综合治理、系统治理、源头治理的新范式。

最后，是战略定位的“根本性”。全会将“美丽中国建设取得新的重大进展”列为“十五五”时期经济社会发展的主要目标之一，并将绿色转型视为“塑造国际合作和竞争新优势的战略之举”。这深刻表明，绿色已从一种约束性条件升维为国家核心竞争力的关键要素。推动经济社会发展全面绿色转型，是“发展观的一场深刻革命”，旨在从根本上解决生态环境问题的结构性、根源性矛盾，塑造以绿色生产力为标志的新发展动能。

（二）“十五五”关键期的承前启后与攻坚意义

党的二十届四中全会深入分析了“十五五”时期我国发展环境面临的深刻复杂变化，明

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确指出该时期在基本实现社会主义现代化进程中具有“承前启后的重要地位”。对于美丽中国建设和绿色发展而言，这五年同样是一个承上启下、实现生态环境根本好转的关键时期，战略节点的特征极为突出。

首先，“承前”体现为坚实的基础与更高的起点。“十四五”时期，我国生态文明建设取得了具有里程碑意义的成就。污染防治攻坚战效果显著，全国地级及以上城市细颗粒物（PM2.5）平均浓度、地表水优良水质断面比例等关键指标均提前或如期完成目标。绿色低碳转型步伐加快，建成了全球规模最大、发展最快的清洁能源体系。更为重要的是，生态文明建设的“四梁八柱”[⑱]制度体系基本形成，中央生态环境保护督察、全国碳排放权交易市场等制度创新发挥了关键作用。这些历史性成就，为“十五五”时期推动更高水平、更全方位的绿色转型奠定了坚实的实践基础、制度基础和信心基础。

其次，“启后”意味着艰巨的挑战与历史的决战。尽管成就斐然，但我国生态环境保护“结构性、根源性、趋势性压力尚未根本缓解”。产业结构偏重、能源结构偏煤、交通运输结构偏公路的状况尚未根本改变。生态环境质量改善的成效还不够稳固，从量变到质变的拐点尚未到来。尤为关键的是，“十五五”时期是实现2030年前碳达峰目标的最后一个五年规划期。这意味着未来五年必须抓住能源、产业、交通结构深度调整的“窗口期”和“机遇期”，推动碳排放总量进入平台期并实现达峰，从而“扭转化石能源等资源消耗和污染物排放刚性增长的趋势”，为2035年基本实现美丽中国目标奠定决定性基础（庄贵阳、王思博，2025）。因此，这一时期的绿色转型，是一场时间紧迫、任务艰巨的攻坚战，其成败直接关系到中长期国家战略目标的实现。

（三）聚焦关键领域的系统部署与制度保障

为确保“全面绿色转型”从战略蓝图转化为实践成果，《建议》提出了一系列重点任务和重大举措，构建了系统清晰的实施路径。其一，要求推动能源供给结构实现质的转变。一方面，以更大力度发展非化石能源，使其从“配角”转变为未来的供应主体。具体任务是加快西北风电光伏、西南水电、海上风电、沿海核电等大型清洁能源基地建设，并积极发展分布式能源，目标是到“十五五”末期，使新增用电需求绝大部分由新增清洁能源满足。另一方面，在保障能源安全的前提下，加强煤炭等化石能源的清洁高效利用，合理控制其消费，推动煤电角色向支撑调节性电源转型，发挥其不可或缺的兜底保障作用。其二，要求构建适应新能源发展的新型电力系统。这是新型能源体系的关键载体，旨在解决绿电“发得出、电网接得住、终

⑱ “四梁”，指的是生态文明制度的四大支柱，包括：环境保护法规、资源节约利用制度、生态修复治理机制和绿色经济发展政策；“八柱”则是在“四梁”的基础上进一步细化，涵盖了更为具体的制度内容。具体包括：环境监管制度体系、生态保护红线制度、生态补偿机制、绿色生活行动制度、生态教育推广制度、生态科技创新制度、国际生态合作机制以及生态安全预警制度等。

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端用得好”的系统性难题。重点任务包括强化电网的智能化、柔性化改造，提升其对高比例可再生能源的接纳与配置能力；大力开发抽水蓄能、新型储能等调节资源；同时深入挖掘需求侧响应潜力，推动源、网、荷、储高效协同，全面提升电力系统的安全韧性与运行效率。

四、“十五五”绿色发展关键路径与政策体系

整体来看，党的二十届四中全会将“加快经济社会发展全面绿色转型”置于“十五五”战略核心，是一次立足历史新方位、把握发展新规律、回应人民新期待的重大战略抉择。为确保《建议》擘画的经济社会发展全面绿色转型和美丽中国建设的宏伟蓝图转化为生动实践，“十五五”时期必须构建一套系统完备、科学规范、运行高效的实施保障与政策体系。这需要超越单一维度的政策工具，从治理体系、市场机制、科技支撑、空间管控、全球协作等多层面协同发力，形成推动经济社会发展全面绿色转型的强大合力。

（一）深化制度创新，构建全覆盖的激励约束体系

“十五五”时期是中国全面建设社会主义现代化国家新征程的关键五年，也是推动经济社会发展全面绿色转型的攻坚阶段。确保这一宏伟蓝图从顶层设计转化为生动实践，其核心引擎与根本保障在于深刻的制度创新。明确提出实现从“能耗双控”向“碳排放双控”的全面转型，是一场涉及发展哲学、治理模式与激励结构的系统性的深刻变革。为此，构建一个系统完备、激励相容、运行高效的“全覆盖激励约束体系”，成为“十五五”时期绿色转型制度建设的首要命题。

一是必须完善促进绿色低碳发展的综合政策工具箱。其一，财税政策应更加精准有力，通过专项资金、税收优惠、政府采购等手段，重点支持新型能源体系建设、传统产业绿色升级、低碳技术研发示范。其二，金融政策需积极发展转型金融、碳金融衍生品等绿色金融工具，创新符合高碳行业转型特征的金融产品，发展绿色保险、绿色担保，防范转型过程中的金融风险（王遥等，2025）。其三，价格政策要深化能源资源市场化改革，完善反映资源稀缺程度、环境损害成本和供求关系的水价、电价、气价机制，全面推行高耗能行业阶梯电价制度。

二是建立系统完备的政绩考核体系。考核的核心在于建立科学、公平、动态的“碳排放预算”分配与管理机制。其一，因地制宜、实事求是。在具体实施中，应综合考虑各地的发展阶段（人均GDP、工业化程度）、结构特征（高碳产业占比、可再生能源潜力）、资源禀赋（森林碳汇、CCUS地质条件）和减排潜力（技术替代成本）。例如，对于可再生能源富集但经济欠发达的西部省份，可分配相对宽松的初期总量预算，但附加高强度下降要求，支持其通过发展绿电产业实现“减碳增长”；对于产业结构偏重、转型难的工业大省，则需设定更具挑战性的预算，但同时配套以技术和资金支持，体现共同但有区别的责任。预算周期应与五年规划同步，并可

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尝试建立跨期存储与借贷机制，增加管理的灵活性。其二，考核必须与一套“强激励、硬约束”的政绩评价与资源调配体系深度捆绑，形成真正的“指挥棒”效应。如将碳排放双控目标完成情况，作为领导干部综合考核评价、选拔任用的关键否决性指标，其权重应与经济增长、社会稳定等传统核心指标并重，甚至在某些生态敏感区域实行“一票否决”。又如，考核优异地区，可获得更高比例的绿色专项转移支付、生态补偿资金，并在地方政府绿色债券发行额度上获得优先支持。反之，对预算超排地区，可实施转移支付扣减、暂停部分高耗能项目财政补贴等惩罚措施。

三是推行企业碳管理，激活市场信号与内生动力。企业是减排行动的最终执行者。管理制度需从“重点用能单位”管理升级为“重点碳排放单位”管理，强制要求企业定期核算与报告碳排放数据，并将其碳排放绩效（如单位产品碳排放强度、碳生产率）作为核心监管指标。全国碳排放权交易市场是核心政策工具，需通过逐步收紧免费配额比例、扩大行业覆盖范围、引入有偿分配与拍卖机制等，使碳价格真实反映减排成本，形成持续且强烈的价格信号。同时，金融机构应依据企业碳表现，开发差异化绿色信贷、债券、保险产品，让低碳者获得更低融资成本，形成市场化的激励闭环。

四是严格项目碳评价，把好源头准入与低碳锁定关。为实现碳排放达峰，必须从增量源头严防高碳项目的“锁定效应”。这要求将项目的全生命周期碳排放影响评估提升至与环评、能评同等重要的地位，作为所有新建、改扩建及重大技术改造项目节能审查和技术改造评估的核心前置条件；对于碳排放强度超过行业先进值或导致区域碳排放总量超出预算的重大项目，应实行“一票否决”或强制要求配套等量的减量替代方案。

五是建立产品碳足迹体系，引领供应链与消费端转型。绿色转型的终端驱动力在于市场需求。需加快构建覆盖主要工业产品、消费品的统一、权威的碳足迹核算标准、认证与标识制度。通过核算产品从原材料获取、生产、运输、使用到废弃处置全过程的碳排放总量，并以直观的标识告知消费者，将无形的碳排放转化为有形的市场选择因素。这将引导大型采购商、品牌商优先选择低碳产品，进而通过绿色供应链管理将减排压力向上游传导，带动全产业链协同降碳。政府可通过公共绿色采购、消费补贴等措施，率先培育低碳产品市场。

这五个维度相互关联、层层递进，共同构成一个从宏观目标分解到微观产品引导、从行政考核到市场驱动、从源头预防到全过程管理的严密制度网络。

（二）以新质生产力为核心引擎，强化“绿智韧”赋能

科技创新是绿色转型的“发动机”。面对全球绿色科技竞争日趋激烈的态势，必须将发展新质生产力摆在突出位置，实现关键技术的自主可控与产业升级的深度融合。基于“绿智韧”深度融合的战略框架，“十五五”时期需在以下关键路径上实现突破。

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一是构建“智慧韧性”的新型能源体系(聚焦绿,依托智,强化韧)。如前文所述,新型能源体系建设是“绿智韧”协同的主战场。其一,在“绿”的层面,核心是大幅提升非化石能源比重,推动煤炭消费达峰并逐步减量。其二,在“智”的层面,旨在构建以智能电网为核心、源网荷储高效互动的新型电力系统。具体而言,将利用人工智能技术精准预测可再生能源发电功率,并优化电网调度策略,从而实现对海量分布式资源的灵活接入与聚合管理。其三,在“韧”的层面,需同步发展大规模储能、氢能等长时调节能力,提升电网对极端天气和网络攻击的抵御力,形成多能互补、区域互济的安全保障格局。与此同时,能源体制机制改革也需以数字化和韧性为导向,建立适应高比例可再生能源的市场体系。

二是实施“精准智能”的碳排放双控制度(目标绿,手段智,保障韧)。全面实施碳排放双控,需要智能技术赋能与韧性管理思维。其一,在“绿”的目标下,建立覆盖全国、各行业、企业的碳排放统计核算与考核体系。其二,在“智”的手段上,依托物联网、区块链技术建立实时、可信的碳排放监测网络,开发基于大数据的碳排放预测预警模型,实现从“结果核算”到“过程智控”的跃升。其三,在“韧”的保障上,碳市场设计需考虑市场波动风险,建立有效的价格稳定机制;为不同地区、行业设置差异化的过渡路径,避免“一刀切”带来的系统性风险,确保转型平稳有序。

三是发展“融合高效”的绿色低碳产业(本质绿,过程智,系统韧)。产业绿色低碳转型是发展新质生产力的内在要求。其一,“绿”是本质,要求构建科技含量高、资源消耗低、环境污染少的产业结构。其二,“智”是过程,通过工业互联网、人工智能、数字孪生等技术实现生产流程的智能化、柔性化和精细化,大幅提升能效与物效。其三,“韧”是系统属性,推动产业链供应链的多元化布局和关键环节的备份能力建设,发展资源循环利用产业以降低对外部资源的依赖,使绿色产业体系本身具备抵御冲击、快速恢复的能力。

四是推行“数字孪生”的生态环境分区管控(底线绿,工具智,空间韧)。生态环境分区管控是优化国土空间开发保护格局的基石。其一,“绿”是空间底线,通过“三区三线”划定并严守生态保护红线。其二,“智”是管理工具,构建“数字孪生”流域或区域,动态模拟评估开发活动对生态环境的影响,实现空间管控方案的智能优化与动态更新。其三,“韧”是空间目标,通过分区管控引导生产力布局与生态系统格局相匹配,保护并增强生态系统的完整性和连通性,从而提升国土空间的长期生态安全韧性,为发展提供可持续的承载空间。

需要进一步指出,国土空间是发展的载体,其利用格局直接决定资源环境承载上限。“十五五”时期有必要推动生态环境分区管控体系刚性落地,作为统筹发展与保护、优化经济布局的“硬约束”和“先手棋”。核心在于推动“三线一单”(生态保护红线、环境质量底线、资源利用上线和生态环境准入清单)成果的深度应用,将其全面融入国土空间规划“一张图”,并作为区域产业布局、结构调整、资源开发、城镇建设、重大项目选址的强制性依据。在此基础

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上，实施差异化的空间发展策略。通过分区管控，引导生产力向环境容量大、市场条件优、发展潜力好的地区集中集聚，推动形成与资源环境承载力相匹配的绿色低碳高质量发展格局。

（三）拓展全球协作，塑造有利的外部环境与竞争新优势

一是充分认识中国绿色发展的世界意义。中国的绿色发展实践，其世界意义首先在于重新定义了“后发优势”的内涵，证明了后发国家在路径选择上具有超越技术追赶的“跃迁潜能”。传统“后发优势”理论侧重于技术模仿、资本引进和结构转移，其潜在叙事常隐含对高污染工业化路径的默认。中国实践的核心启示在于，利用后发优势、利用最新的技术革命（如可再生能源、数字技术）和前沿的治理理念（如生态文明），主动选择并开辟一条新路。这就是“弯道超车”与“换道发展”的实质。如在能源领域，中国没有完全重复从煤炭到油气再到可再生能源的线性更替，而是凭借强大的产业组织能力与市场规模，在煤炭清洁利用的同时，同步打造了全球最完整、最具竞争力的光伏、风电、动力电池等新能源产业链，从而在能源结构转型中占据了产业制高点。这种“路径创造型”后发优势，为发展中国家提供了避开“先污染、后治理”宿命的现实可能性，即不必以牺牲环境为代价换取初级工业化，而是可以在发展早期就将绿色要素内置于增长引擎之中。对发达国家而言，中国的绿色发展破解了“现代化与西方化”的二元对立迷思，证明了大规模人口国家走绿色发展道路的政治经济可行性（黄承梁，2022）。西方某些环境理论与发展模型常将环境保护与经济增长，尤其是与贫困人口的生计改善置于一种静态的权衡关系中，并隐含地认为，只有达到较高收入水平后，社会才有意愿和能力承担绿色成本。中国作为一个拥有超过14亿人口、区域发展不平衡的发展中大国，其绿色发展从不是脱离发展的“为环保而环保”，而是始终强调“绿水青山就是金山银山”，致力于推动生态产品价值实现。

二是持续推动绿色“一带一路”建设成为中国引领全球生态治理的重要平台。中国在“一带一路”沿线国家推广绿色基础设施、绿色能源、绿色金融合作，帮助发展中国家实现绿色转型。金砖国家新工业革命伙伴关系具有全球代表性，是中国“十五五”时期建设金砖国家工业能力中心、引领新工业革命伙伴关系发展的重要平台，其合作模式也为全球南方崛起发挥了示范引领作用。中国在全球绿色产业链供应链中发挥着关键作用。中国在光伏组件、风电设备、新能源汽车等领域占据全球市场领先地位，不仅为全球提供了优质的绿色产品，还通过技术转让、产能合作等方式帮助其他国家发展绿色产业。这些贡献使绿色成为全球合作的底色，“十五五”时期要继续发扬光大。

三是进一步彰显大国担当、大国引领。绿色转型是在开放条件下推进的，必须统筹国内国际两个大局。中国作为全球生态文明建设的重要参与者、贡献者、引领者，“十五五”时期应以更加积极的姿态参与全球生态治理体系。坚定维护《联合国气候变化框架公约》及其《巴黎

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协定》的主渠道地位，持续落实“双碳”承诺，以实实在在的行动增强全球气候治理的“领导力”（张永生等，2021）。同时，积极利用G20、金砖国家、上海合作组织、“一带一路”绿色发展国际联盟等多边平台，推动绿色基建、绿色能源、绿色金融等领域的务实合作，将中国的市场优势、产业优势转化为规则标准优势。特别是面对国际上单边主义、保护主义抬头的“绿色壁垒”，需采取“合作”与“斗争”相结合的策略。一方面，加强绿色技术、贸易、投资、标准等领域的双边与区域合作，推动国际标准衔接互认，化解贸易摩擦。另一方面，对于以“气候”为名行遏制之实的打压行为，要进行有理有利有节的斗争，坚定维护我国发展权益。

综上所述，在全球格局深刻演变、单边主义抬头之际，中国的全面绿色转型战略，于“十五五”时期将塑造一种超越传统地缘政治博弈的深层新竞争力。这一转型，也必然在大国战略互动中扮演“稳固锚”与“动力源”的关键角色。

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Pursuing Green Development: From the 14th to the 15th Five-Year Plan

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Abstract: *Guided by Xi Jinping Thought on Ecological Civilization, this paper systematically reviews and interprets the historic achievements of China's green development during the 14th Five-Year Plan (FYP) period, drawing strategic implications for the 15th FYP. The analysis demonstrates that, during the 14th FYP period, China successfully broke free from the conventional "pollute first, treat later" trajectory presupposed by the Environmental Kuznets Curve. Through multidimensional breakthroughs—including leapfrog progress in energy structure decarbonization, fundamental improvements in ecological quality, the systemic rise of green productive forces, modernization of environmental governance, and strengthened global ecological leadership—China achieved an initial decoupling of economic growth from resource consumption and environmental degradation, thereby contributing distinctive Chinese insights to global sustainable development. As the 15th FYP period represents the decisive window for achieving carbon peaking, this paper proposes a coherent implementation framework anchored in the institutional transition toward the "Dual Control" of carbon emissions, encompassing total volume and intensity, driven by the accelerated integration of "green-intelligent-resilient" new quality productive forces, and supported by expanded, leadership-oriented global cooperation. The proposed framework aims to provide Provide reference in theory and practice for advancing a comprehensive green transformation of the economy and society, ultimately painting a new picture of Chinese modernization characterized by harmony between humanity and nature.*

Keywords: *Green development; Comprehensive green transition; 14th Five-Year Plan; 15th Five-Year Plan; New quality productive forces*

JEL Classification Codes: O13; Q56; Q58

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1. Introduction

Throughout the history of the global economic development theory, the Environmental Kuznets Curve (EKC) has long held a dominant position. This classic EKC hypothesis posits an inverted U-shaped relationship between environmental degradation and per capita income.

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At lower income levels, environmental pressures typically intensify with economic growth. In contrast, at higher income levels, certain pollution indicators may decline due to technological progress, industrial restructuring, and strengthened environmental regulation (Grossman & Krueger, 1991). This framework implicitly endorses a "pollute first, treat later" development path, serving as an intellectual rationale for the industrialization trajectories of many developed countries. Moreover, it led numerous developing economies—implicitly benchmarking themselves against Western modernization—to conflate modernization with Westernization, thereby failing to forge a mutually beneficial pathway that could advance economic growth and ecological protection simultaneously.

Xi Jinping Thought on Ecological Civilization, as a core component of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, constitutes a comprehensive and logically coherent theoretical system for ecological governance. It is anchored in the core principle of harmony between humanity and nature; grounded in the foundational tenet that "Lucid waters and lush mountains are invaluable assets"; oriented toward the value that a sound ecological environment is the most inclusive form of public well-being; structured by the systemic perspective that mountains, rivers, forests, farmlands, lakes, grasslands, and deserts form a community of life; and safeguarded by commitment to protecting the environment with the strictest systems and most rigorous legal frameworks. The theoretical innovation of this thought manifests in three fundamental transcendences. First, it transcends the narrow Western environmental-economic view that frames ecological protection as a growth burden by repositioning it as an intrinsic requirement for high-quality development. Second, it overcomes the traditional development-economics dichotomy that pits economic growth against environmental protection, revealing their dialectical unity. Third, it transcends fragmented governance approaches by advancing a systemic, holistic, and synergistic vision for the construction of ecological civilization. This theoretical depth and coherence have enabled China to launch and sustain a profound, nationwide green transformation.

In the new era, guided by Xi Jinping Thought on Ecological Civilization, China has broken away from the linear evolutionary paradigms of traditional industrialization theories. By advancing Chinese modernization characterized by the harmony between humanity and nature—and driven by the synergistic logic of leapfrog development, innovation-led growth, and systems thinking—China has forged a new path of green development. During the 14th FYP period (2021-2025), China manifested a developmental miracle defined by the "Five-Pronged Synchronization" of industrialization, informatization, urbanization, agricultural modernization, and green transformation. By adopting a parallel-track development strategy, China has bypassed the traditional "serial-track" model, achieving coordinated progress across multiple dimensions of modernization through temporal compression. Fundamentally, China has articulated a framework of green productive forces grounded in the axiom that "protecting the ecological environment is equivalent to protecting productive forces, and improving the ecological environment is equivalent to developing productive forces." By internalizing green development as a core variable within the economic growth function, China has orchestrated a structural transition from factor-driven expansion to innovation-led growth. In contrast to the benchmark assumptions of neoclassical growth theory—which prioritize capital accumulation and labor inputs while treating ecological

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constraints as externalities—China's New Development Philosophy institutionalizes innovation and ecological sustainability as primary orientations. Furthermore, through the aggressive promotion of green technological innovation and the iterative refinement of environmental governance systems, China has substantially enhanced the "green density" (i.e., the ecological efficiency of its economic output). In doing so, they have achieved a progressive relative decoupling of economic expansion from resource depletion and environmental degradation.

Additionally, the systemic operationalization of the principle that "lucid waters and lush mountains are invaluable assets" during the 14th FYP period signifies a qualitative leap in ecological civilization theory and a profound breakthrough in mechanisms for realizing ecological value. Local pilot programs, such as "ecological banks," have effectively bridged the gap between natural resources and financialized assets (Qin et al., 2025); "carbon inclusion mechanism" schemes have effectively incentivized a pro-environmental behavioral shift among the public[1]; A suite of innovations for the value realization of ecological products has been effectively implemented nationwide. Notably, these efforts have systematically quantified and marketized previously "non-market" natural endowments—clean air, pristine water, and scenic landscapes—ensuring that the stewards of these ecological assets receive tangible rewards. This, in turn, has injected robust endogenous momentum into the sustainable growth of green industries.

From a global perspective, China's presidency of the COP15 and its leadership in securing the Kunming-Montreal Global Biodiversity Framework provide a distinctly Chinese blueprint for global conservation[2]. Proposed by China, the Community with a Shared Future for Mankind transcends the narrow parochialism of nation-state interests, offering a transformative paradigm for South-South cooperation and North-South dialogue. Recently, China's green development trajectory has provided multifaceted insights and vital empirical contributions to global environmental governance, offering novel conceptual frameworks and practical benchmarks for international governance mechanisms (Huan, 2025). Notably, China's massive afforestation initiatives have contributed approximately one-quarter of the world's newly added green cover, establishing China as the global leader in the scale and velocity of ecological restoration. Collectively, these achievements suggest that the Chinese model of green development possesses significant replicability and heuristic value for the international community.

Building upon this series of profound theoretical innovations and extensive practical explorations, we systematically review the comprehensive and pioneering achievements of China's green development during the 14th FYP period under the scientific guidance of Xi Jinping Thought on Ecological Civilization, while synthesizing the invaluable experience and insights accumulated along the way. At this historical juncture, the 15th FYP period marks a critical phase in laying the foundation for achieving socialist modernization. Guided by the strategic deployments of the 20th CPC Central Committee's Fourth Plenum, China will prioritize its efforts with the comprehensive

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[1] Source: Shanghai Municipal Bureau of Ecology and Environment, "Measures for the Administration of Carbon Inclusion in Shanghai," October 30, 2025, https://www.shanghai.gov.cn/gwk/search/content/5c8129b3a2b340ad8a05947183c22587.

[2] Source: Xinhua News Agency, "Interpretation of President Xi Jinping's Keynote Speech at the Leaders' Summit of the 15th Conference of the Parties to the Convention on Biological Diversity (COP15)," October 13, 2021, https://www.gov.cn/xinwen/2021-10/13/content_5642189.htm.

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green transformation of development as the overarching link. Moreover, the deep integration of "green, intelligent, and resilient" attributes will be at the core, along with the "Dual Carbon" (carbon peaking by 2030 and carbon neutrality by 2060) goals as the strategic driver. The nation aims to achieve strategic and systematic breakthroughs in key domains: constructing a new energy system, cultivating new quality productive forces, optimizing territorial spatial patterns, innovating policy support mechanisms, and deepening cooperation in global environmental governance. Collectively, these breakthroughs will lay a more solid green foundation for realizing a new vision of Chinese modernization defined by the harmonious coexistence between humanity and nature.

2. Historic Achievements of Green Development During the 14th FYP Period

During the 14th FYP period, China upheld the principle that "lucid waters and lush mountains are invaluable assets," elevating ecological civilization construction to a prominent position in national governance. By advancing economic and social development in close coordination with ecological and environmental protection, China achieved a leapfrog transition—from a primary focus on winning the tough battle against pollution to the comprehensive construction of a Beautiful China. Following the pathway set forth by the 20th CPC National Congress—emphasizing the coordinated advancement of carbon reduction, pollution abatement, ecological expansion, and economic growth—China employed powerful institutional instruments such as Central Ecological and Environmental Protection Inspections to firmly enforce the principle of "shared responsibility between Party and government, and dual responsibilities for specific posts." As a result, green has become the defining hallmark of high-quality development. In contrast, green development has solidified as a foundational logic and a shared value pursuit across society.

2.1 Major Achievements

First, in the realm of the energy revolution, China has achieved leapfrog progress in its clean and low-carbon transition while substantially strengthening its energy security. As the primary front line of green transformation, the energy sector delivered breakthrough progress and historic achievements during the 14th FYP period. China has built the world's largest and fastest-growing renewable energy system, with the share of installed renewable power capacity rising from approximately 40% at the end of the 13th FYP period (2016-2020) to around 60% by 2025[3]. Moreover, annual additions of wind and solar power capacity have repeatedly surpassed 100 million kilowatts, reaching an unprecedented scale and pace. In 2024, China's installed renewable power capacity surpassed coal-fired capacity for the first time, marking a fundamental structural turning point in the national electricity supply system. Since then, the "green intensity" of energy consumption has risen markedly. Additionally, the share of non-fossil energy in China's total energy consumption increased from 15.9% in 2020 to 19.8% in 2024, reflecting a steady annual

[3] Source: National Energy Administration (NEA) of China, "Press Conference on the Grid-Connected Operation of Renewable Energy in the First Three Quarters of 2025," October 31, 2025, https://www.nea.gov.cn/20251031/7be6728f6d8a48a4955a24a45013b37f/c.html.

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gain of approximately 1 percentage point and exceeding the targets set under the 14th FYP[4]. Importantly, this transition has progressed steadily while firmly safeguarding energy security. During the first four years of the 14th FYP, China's domestic energy production accounted for more than 90% of its incremental consumption, with nearly half of the newly added power generation coming from renewables. Across society, one in every three kilowatt-hours of electricity now comes from green sources, and more than half of the world's new energy vehicles operate in China—vividly demonstrating that the nation's "energy rice bowl" is held more securely and sustainably. At the same time, technological innovation has provided powerful support: China accounts for over 40% of global new energy patents and leads the world in key indicators such as photovoltaic conversion efficiency, single-unit capacity of offshore wind turbines, and installed scale of new energy storage—delivering robust technological momentum for the ongoing energy transition[5].

Second, in terms of environmental quality improvement, the nationwide battle to prevent and control pollution delivered historic, systemic results, markedly enhancing public satisfaction with the ecological environment. During the 14th FYP period, China deepened and broadened its pollution control efforts, yielding striking improvements in environmental quality and steadily rising public approval of ecological conditions. In terms of air quality, average fine particulate matter (PM2.5) concentrations in China's prefecture-level and above cities fell from 35 μg/m³ in 2020 to 29.3 μg/m³ in 2024—a reduction of 16.3%. The proportion of days with good or excellent air quality increased to 87.2%, heavy pollution episodes declined sharply, and blue skies with white clouds became the norm. Regional governance produced amplified results: PM2.5 levels in the Beijing-Tianjin-Hebei region and surrounding areas dropped by 18% relative to 2020, while concentrations in the Fenwei Plain fell by 20%. Parallel gains were realized in China's aquatic environment. For the first time, the share of surface water monitoring sections meeting excellent quality standards (Grades I-III) exceeded 90%, reaching 90.4%. Moreover, the main streams of the Yangtze and Yellow Rivers maintained stable Grade II water quality, and black and odorous water bodies in cities at or above the prefectural level were essentially eliminated. This allowed for clear waters and green riverbanks, an increasingly familiar sight. In the soil domain, China successfully managed pollution risks by achieving a stable, safe utilization rate above 90% for contaminated arable land in 2024, while effectively safeguarding the safety of key construction land—thereby upholding the essential baseline of environmental security for human settlements[6].

Third, in terms of ecological restoration, China achieved comprehensive and systemic optimization of its national territorial spatial pattern. During the 14th FYP period, China's ecological restoration and territorial spatial planning underwent a historic transformation—

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[4] Source: National Energy Administration (NEA) of China, "Pursuing Green Innovation: Accelerating Energy Transition During the 14th FYP," October 31, 2025, https://www.nea.gov.cn/20251017/293d07cfb51f483eab7e7ab0b279b343/c.html.

[5] Source: CCTV.com, "World's Largest and Fastest-Growing: Chronicling China's Global Leadership and Milestone Achievements in High-Quality Energy Development," August 26, 2025, https://news.cctv.com/2025/08/26/ARTIRdW8JSyhgc2BZ3THuGSL250826.shtml.

[6] Source: The National People's Congress of the People's Republic of China, "Report of the State Council on the State of the Environment and the Achievement of Environmental Protection Targets for 2024," April 28, 2025, http://www.npc.gov.cn/c2/c30834/202504/t20250428_444977.html.

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from quantitative accumulation to qualitative leaps, from localized interventions to nationwide coordination, and from reactive remediation to proactive, forward-looking governance. At the core of this shift was the establishment of a "Multi-Plan Integration" governance system, anchored in territorial spatial planning and enforced through strict land-use regulation. As such, this institutional reform resolved the long-standing fragmentation of planning regimes and associated spatial conflicts. Through rigorous scientific assessment and precise delineation, more than 30% of China's terrestrial land area was placed under Ecological Conservation Red Lines—designated as inviolable "red lines" for protection[7]. Notably, this structural optimization demarcated boundaries among production, living, and ecological spaces, creating permanent "safety islands" for core ecological function zones and environmentally sensitive or fragile areas. Moreover, it provides a robust foundation for natural self-recovery and long-term ecological succession. For the first time, the accelerated development of a protected area system centered on national parks achieved institutionalized, holistic protection and systematic management of the nation's most vital natural heritage, ushering in a new era of state-recognized, legally guaranteed ecological conservation[8]. In parallel, the national ecological security barrier system was further consolidated. A strategic framework for major ecological protection and restoration projects—centered on the "Three Regions and Four Belts" (Qinghai-Tibet Plateau ecological barrier, key ecological zones of the Yellow and Yangtze rivers, Northeast Forest Belt, northern sand-control belt, southern hilly and mountainous belt, and coastal zone)—has largely taken shape, strengthening the backbone of national ecological security[9]. Collectively, through the systematic optimization of territorial spatial patterns and integrated ecological restoration, China has historically reversed the trajectory of ecological degradation and constructed a forward-looking green spatial framework. Thus, it lays a solid ecological foundation for the nation's long-term sustainable development and the shared global endeavor of building a beautiful planet.

Fourth, in terms of green productive forces, China's industrial structure underwent profound restructuring, while new growth engines achieved a historic leap forward. During the 14th FYP period, China harnessed high-level ecological and environmental protection to accelerate the development of *new quality productive forces*, enabling simultaneous gains in both the economic value and green intensity of growth. First, China's energy consumption per unit of GDP declined by 11.6% cumulatively, equivalent to approximately 1.1 billion tons of carbon dioxide emissions avoided. This notable pace of efficiency improvement has placed China among the leading economies worldwide. Second, industrial restructuring yielded striking results: environmental impact assessment (EIA) approvals for "Two-High" projects (high-emission, high-pollution industries) continued to decline. In contrast, approvals for high-technology and green sectors—

[7] Source: CCTV.com, "The Ecological Conservation Red Line System Demonstrates Great-Power Responsibility, Fortifying the 'Three Regions and Four Belts' National Ecological Security Barrier,"August 15, 2023, https://news.cctv.com/2023/08/15/ARTIwgomjIfud0wsiV9lyMgd230815.shtml.

[8] Source: The National People's Congress of the People's Republic of China, "National Park Law of the People's Republic of China," September 24, 2025, http://www.npc.gov.cn/npc/c2/c30834/202509/t20250912_447755.html.

[9] Source: China Development and Reform Press, "The Story of Seven Visual Blueprints for the Final Phase of the 14th FYP: Safeguarding National Ecological Security," October 30, 2025, https://www.ndrc.gov.cn/wsdwhfz/202510/t20251030_1401268.html.

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particularly wind power and new energy vehicles (NEVs)—expanded rapidly. In the first half of 2025, year-on-year growth in EIA approvals for these green categories reached 44.4% and 31.3%, respectively[10]. Third, the green manufacturing system advanced rapidly, according to a news released by the Ministry of Industry and Information Technology in September 2025, the number of national-level green factories rising to 6,430[11]. Green and low-carbon industries also emerged as powerful new drivers of foreign trade. The export value of the so-called "New Three"—electric vehicles, lithium-ion batteries, and photovoltaic products—grew 2.6 times compared with 2020. China now supplies more than 70% of global photovoltaic modules and 60% of wind power equipment[12]. In 2024, China's NEV output exceeded 13 million units, securing its position as the world's largest producer and seller for the tenth consecutive year and vividly demonstrating the formidable momentum of green technological innovation and industrial competitiveness[13].

Fifth, in the context of modernizing national governance, China's regulatory capacity underwent an intelligent transformation, bolstered by the robust implementation of market-based mechanisms. During the 14th FYP period, China's ecological and environmental governance framework advanced markedly toward modernization. First, China established the world's most expansive and integrated ecological monitoring network, comprising approximately 33,000 monitoring stations nationwide. By integrating unmanned aerial vehicles (UAVs), AI-driven acoustic recognition, and automated lights-out laboratories, the Chinese government digitized the sampling and analytical life-cycle. Importantly, this technological leap has substantially enhanced both monitoring efficiency and data precision[14]. Furthermore, China's intelligent enforcement systems have fundamentally reshaped environmental supervision. By deploying an integrated "space-air-ground-water-land-sea" detection framework—utilizing satellite remote sensing and infrared imaging—authorities transitioned to non-intrusive, off-site oversight. Consequently, between January and August 2025, on-site inspections across China decreased by 30%, while the accuracy of problem detection increased by 10-25 percentage points, thereby facilitating the successful rectification of more than 260,000 environmental violations[15]. Second, the evolution of China's market-oriented environmental mechanisms achieved milestone breakthroughs. The China National Carbon Emissions Trading Market—now the world's largest in terms of covered greenhouse gas emissions—maintained stable and effective operations. By December 31, 2025, the market's cumulative allowance-trading volume reached 865 million tons, representing a total

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[10] Source: The Information Office of the State Council, "State Council Information Office Press Conference Series: 'High-Quality Completion of the 14th FYP' — Achievements in Economic and Social Development during the 14th FYP," July 9, 2025, https://www.gov.cn/lianbo/fabu/202507/content_7031379.htm.

[11] Source: China Industry and Information Technology News, "MIIT: China Has Cultivated a Total of 6,430 National Green Factories and 491 Green Industrial Parks," September 9, 2025, https://www.cnii.com.cn/yw/202509/t20250909_683782.html.

[12] Source: The State Council of the People's Republic of China, "China's Actions on Carbon Peaking and Carbon Neutrality," November 8, 2025, https://www.gov.cn/zhengce/202511/content_7047492.htm.

[13] Source: Xinhua News Agency, "China's Production and Sales of New Energy Vehicles Rank First Globally for the 10th Consecutive Year," September 9, 2025, https://www.gov.cn/yaowen/liebiao/202509/content_7039823.htm.

[14] Source: Guangming Online, "UAV Sampling and 'Darkroom' Laboratories: China's Ecological Monitoring Enters the 2.0 Era of Intelligence," September 19, 2025, https://kepu.gmw.cn/eco/2025-09/19/content_38297532.htm.

[15] Source: Jiang Xiaoping, "Ministry of Ecology and Environment: Over 260,000 Environmental Issues Rectified During the 14th FYP," September 19, 2025, https://news.cnr.cn/native/gd/20250919/t20250919_527368311.shtml.

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transaction value of 57.66 billion yuan. In parallel, the China Certified Emission-Reduction (CCER) framework—the national voluntary carbon credit system—progressed steadily. By year-end 2025, 33 voluntary projects were officially registered, yielding 17.76 million tons of verified emission reductions[16].

Sixth, in the domain of global contributions, China has emerged—through resolute action and an open stance—as a key participant, major contributor, and leading force in advancing global ecological civilization. During the 14th FYP period, China formally committed to carbon peaking and carbon neutrality goals and established the comprehensive "1+N" policy framework, converting high-level pledges into systematic, concrete action ('1' denotes the overarching master plan and 'N' refers to a suite of supporting implementation measures). First, China achieved its 2030 Nationally Determined Contribution (NDC) target for renewable energy installed capacity ahead of schedule. In doing so, it injected powerful momentum into the global climate response. Through exports of green products, China enabled other countries and regions to also reduce carbon emissions by approximately 4.1 billion tons over the period[17]. Second, in international cooperation, China actively advanced multilateral climate processes while expanding South-South collaboration through initiatives such as deepening the Green Belt and Road and launching the Kunming Biodiversity Fund to support biodiversity conservation in developing countries. Third, China's innovation and manufacturing strengths in green technology sectors—including electric passenger vehicles, lithium-ion batteries, and solar cells—have delivered high-quality, inclusive green products and services worldwide, enriching global green supply and translating the vision of "building a clean and beautiful world" into a tangible reality.

2.2 Invaluable Experience and Fundamental Insights

China's green development path during the 14th FYP period represents a systemic transformation that embeds ecological civilization across all dimensions and processes of economic, political, cultural, and social development. Guided by ecological priority and green development, it constitutes a new model of high-quality growth. The achievements of the 14th FYP have laid a robust material foundation for the 15th FYP transition and generated valuable experience that provides clear methodological guidance for implementing a comprehensive green transition during the 15th FYP period.

First, with respect to the material foundation, a series of landmark achievements has created a solid platform for further progress. In the energy sector, the rapid rise in renewable energy capacity and China's 10 consecutive years of ranking first globally in new energy vehicle production and sales provide strong industrial and technological underpinnings for building a new energy system and advancing a green transportation revolution. In environmental quality, the sharp decline in PM2.5 concentrations and the fundamental improvement in river water quality demonstrate the effectiveness of large-scale, high-intensity governance strategies and integrated policy instruments.

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[16] Source: Gao Jing, "China's National Carbon Market Maintained Stable and Orderly Operation in 2025," January 1, 2026, https://www.news.cn/fortune/20260101/f1a3e548d93c4fc7bcf00efc409daaed/c.html.

[17] Source: Xinhua News Agency, "China's Actions on Carbon Peaking and Carbon Neutrality," November 8, 2025, https://www.gov.cn/zhengce/202511/content_7047492.htm.

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In ecological protection, sustained increases in forest cover and the comprehensive delineation of Ecological Conservation Red Lines have established essential spatial safeguards for green expansion and ecological security barriers. Together, these accomplishments demonstrate that China now possesses the capacity to address environmental challenges through development and to generate new growth drivers through green transformation.

Second, the hard-won experiences from the 14th FYP provide vital compass points for achieving a truly comprehensive green transition. China has shown that institutional innovation forms the bedrock of lasting change. The rigorous Central Ecological and Environmental Protection Inspections have held local leaders accountable with unyielding resolve, while the national carbon market has turned emissions cuts into market-driven incentives. These mechanisms demonstrate that only the strictest systems and rule-of-law frameworks can overcome entrenched resistance and drive deep transformation. Technological innovation stands as the powerful engine at the heart of it all. By propelling green and low-carbon industries to become surging new forces in foreign trade, China has demonstrated how scientific and technological breakthroughs cultivate new quality productive forces and forge fresh edges in global competition. As such, it turns cutting-edge ideas into tangible advantages that benefit both domestic growth and the world. Systems thinking emerges as the indispensable guiding method. In key domains, China has successfully implemented the principle of coordinated progress across carbon reduction, pollution control, green expansion, and economic growth. This validates the viability of synergistic, multi-goal governance and points to a clear path for scaling up such coordination more broadly and in greater depth during the 15th FYP period. Drawn directly from China's pioneering practice, these insights constitute invaluable intellectual capital—essential for steering the comprehensive green transition with confidence and clarity.

Taken together, these remarkable achievements and profound experiences have built a robust foundation for realizing a Beautiful China and a distinctive form of modernization in which humanity lives in true harmony with nature—extending well beyond the 15th FYP period into the longer future. In doing so, they deliver China's enduring and substantial contribution to humanity's shared quest for sustainable development worldwide.

3. Distinctive Strategic Features of China's Green Development Based on the 15th FYP Recommendations

The Report to the 20th CPC National Congress explicitly states that "Promoting green and low-carbon transformation of economic and social development is a critical link in achieving high-quality development," thereby defining the intrinsic relationship between green transition and high-quality development.

Building on this foundational principle, the *Recommendations of the Central Committee of the Communist Party of China for Formulating the 15th Five-Year Plan for National Economic and Social Development* (hereinafter referred to as the *Recommendations*)—Adopted at the Fourth Plenary Session of the 20th Central Committee of the Communist Party of China—designate "accelerating the comprehensive green transition of economic and social development and building a Beautiful China" as a major strategic task and overarching objective for the period. The

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deliberate use of the term "comprehensive" marks a historic turning point. During the 15th FYP period, China's ecological civilization endeavor is set to advance from targeted breakthroughs and pilot initiatives to a profound, systemic transformation of the entire economic and social development model.

3.1 Profound Theoretical Connotations of the Comprehensive Green Transition

First, the transition is distinguished by its comprehensiveness. It transcends the conventional view that confines green transformation to production sectors such as energy and industry, instead requiring its integration across all dimensions and throughout the economic, political, cultural, and social development. Notably, this requires fundamental changes in industrial and energy structures, spatial patterns, production modes, consumption behaviors, and even core value systems. For example, the *Recommendations* call not only for constructing a new energy system but also for strengthening incentive mechanisms for green consumption and cultivating sustainable lifestyles—reflecting a systematic reconfiguration of the full development chain and every stage within it.

Second, the transition is defined by the systemic nature of its governance pathway. The Plenary Session emphasized "using carbon peaking and carbon neutrality as the driving force to synergistically advance carbon reduction, pollution control, green expansion, and economic growth," thereby revealing the coordinated logic at the heart of comprehensive green transformation. Rather than pursuing isolated, linear governance focused on single objectives, this approach treats climate mitigation (carbon reduction), environmental quality improvement (pollution abatement), ecological capacity enhancement (green expansion), and sustained economic vitality (growth) as an integrated, mutually reinforcing whole. By aligning planning and coordinated policy instruments, it seeks to deliver simultaneous environmental and economic benefits (Zhou, 2025). Furthermore, this demands a shift away from fragmented approaches—"addressing carbon in isolation" or "treating pollution separately"—toward a new paradigm centered on holistic, systemic, and source-oriented governance.

Finally, the transition embodies the fundamental nature of its strategic positioning. The Plenary Session identified "achieving major new progress in the construction of a Beautiful China" as one of the principal goals of economic and social development during the 15th FYP period, while framing green transformation as a "strategic move to shape new advantages in international cooperation and competition." This elevation signifies a profound shift in which green development is no longer merely a constraint or side condition but a core driver of national competitiveness. Advancing this comprehensive green transition represents a profound revolution in the very concept of development ,aimed at fundamentally resolving the structural and root contradictions underlying ecological challenges while generating powerful new momentum driven by green productive forces—positioning China to lead the global shift toward sustainable modernization.

3.2 The Transitional and Decisive Significance of the 15th FYP

The Fourth Plenary Session of the 20th CPC Central Committee analyzed the profound shifts in China's development landscape during the 15th FYP period, identifying it as a pivotal transition toward the basic realization of socialist modernization. For the "Beautiful China" initiative

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and green development, these five years represent a strategic milestone—a critical juncture for consolidating past progress and achieving a fundamental shift in ecological quality.

First, the "consolidation of past achievements" is reflected in a solid foundation and a markedly elevated starting point**.** During the 14th FYP period, China's ecological civilization construction achieved milestone progress. Key indicators—including average PM2.5 concentrations in prefecture-level and above cities and the proportion of surface water sections meeting excellent quality standards—were met or exceeded ahead of or on schedule. The pace of green and low-carbon transformation also accelerated significantly, establishing the world's largest and fastest-growing clean energy system. The core institutional framework for ecological civilization—often metaphorically described as the "four beams and eight pillars"[18]—has largely taken shape, establishing a comprehensive system of laws, mechanisms and accountability structures for environmental governance. Importantly, institutional innovations such as the Central Ecological and Environmental Protection Inspection system and the national carbon emissions trading market have played decisive roles. These historic accomplishments have laid a robust, practical, institutional, and confidence-building foundation for advancing a higher-level and more comprehensive green transition during the 15th FYP period.

Second, the "initiation of future breakthroughs" signifies formidable challenges and a decisive historical battle. Despite remarkable progress, the structural, root-cause, and trend-related pressures confronting China's ecological and environmental protection efforts have not yet been fundamentally alleviated. The heavy industrial bias of the industrial structure, the coal-dominated energy mix, and the road-dominated transportation system remain largely unchanged. Despite substantial improvements, environmental quality gains remain fragile, and the critical inflection point from quantitative improvement to qualitative transformation has yet to materialize. Most crucially, the 15th FYP represents the final five-year planning period before the 2030 carbon peaking deadline. Thus, China must utilize the 15th FYP period to decisively seize the window of opportunity for deep structural adjustments in energy, industry, and transportation. By transitioning total carbon emissions into a plateau and peaking phase, China aims to decouple economic growth from its rigid reliance on fossil fuel consumption and reverse the upward trajectory of pollutant emissions. Doing so will lay a decisive foundation for basically realizing the Beautiful China vision by 2035 (Zhuang & Wang, 2025). Furthermore, green transition during this period constitutes a time-sensitive and arduous campaign whose outcome will directly determine the realization of China's medium- and long-term national strategic objectives.

3.3 Systemic Deployment and Institutional Safeguards in Key Areas

To turn the strategic blueprint for a "comprehensive green transition" into tangible outcomes, the *Recommendations*—outline a systematic implementation pathway. First, China is orchestrating a qualitative transformation of its energy supply structure**.** This involves developing non-fossil

[18] The "four beams and eight pillars" metaphor refers to the core structural components of China's ecological civilization institutional system, encompassing key laws, mechanisms, and responsibilities (e.g., property rights for natural resources, ecological compensation, strict enforcement systems, and accountability frameworks) that form the foundational "architecture" for long-term environmental governance.

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energy sources to transition them from a supplementary role to the primary pillar of the national energy mix. Key priorities include accelerating the deployment of large-scale clean energy bases (Northwest wind and solar, Southwest hydropower, and coastal offshore wind and nuclear power) while expanding distributed energy systems. The objective is to meet most of the incremental electricity demand through new clean energy by the end of the 15th FYP. Simultaneously, while ensuring national energy security, China will advance the clean and efficient use of fossil fuels. Coal-fired power will transition from a baseload source to a supporting and regulatory role, providing essential grid stability and backup capacity. Second, the development of a "New-Type Power System" serves as the critical framework for this transition. This system addresses the systemic challenges of renewable integration—ensuring green power is reliably generated, seamlessly integrated into the grid, and efficiently utilized at the consumption end. Strategic tasks include the intelligent, flexible upgrading of the power grid to enhance its capacity for integrating high shares of renewable energy. Additionally, China will scale up flexibility resources, such as pumped-storage and new energy storage technologies, while leveraging demand-side response potential. By fostering "source-grid-load-storage" coordination, these initiatives will enhance the power system's resilience and efficiency.

4. Key Pathways and Policy Framework for China's Green Development in the 15th FYP

Overall, the Fourth Plenary Session of the 20th CPC Central Committee elevated the "acceleration of a comprehensive green transition in economic and social development" to the strategic core of the 15th FYP. This landmark decision represents a major strategic choice—grounded in a new historical orientation, guided by an evolving understanding of development laws, and responsive to the public's heightened expectations for a better environment. To translate the ambitious blueprint for a comprehensive green transition and the building of a "Beautiful China" into tangible practice, the implementation strategy for the 15th FYP must be anchored by a systematic, scientifically grounded, and highly operational framework. China must move beyond single-dimensional policy instruments and instead foster synergy across multiple domains: governance systems, market mechanisms, technological innovation, spatial planning, and global cooperation. By mobilizing these integrated forces, China will generate a powerful synergy to drive the comprehensive green transformation of its economic and social development.

4.1 Deepening Institutional Innovation and Building a Comprehensive Incentive-Constraint Framework

The 15th FYP period represents a pivotal juncture in China's "New Journey" toward a modern socialist country. It serves as the decisive "assault phase" for the nation's comprehensive green transformation**.** Ensuring that this ambitious top-level design is translated into effective practice requires profound institutional innovation as its primary engine. A centerpiece of this era is China's strategic shift from the "Dual Control of Energy Consumption" to the "Dual Control of Carbon Emissions"—encompassing both total volume and intensity. This systemic transformation redefines the country's development philosophy, governance modalities, and incentive structures.

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Consequently, establishing a robust, incentive-compatible, and high-efficiency "Universal Incentive-Constraint Framework" stands as the foremost institutional imperative for China's green transition during the 15th FYP period.

First, the Chinese government must refine its multifaceted toolkit across three primary domains. In fiscal and taxation policy, measures should be more targeted and robust, leveraging special funds, tax incentives, and green government procurement to prioritize China's "New Energy System," the green upgrading of traditional industries, and the R&D and demonstration of low-carbon technologies. Furthermore, financial policies must proactively promote instruments such as transition finance and carbon derivatives, develop products tailored to the decarbonization pathways of China's high-carbon industries, and expand green insurance and guarantees to mitigate systemic transition risks (Wang et al., 2025). Lastly, pricing policies should deepen market-oriented reforms, ensuring that water, electricity, and gas prices accurately reflect resource scarcity, environmental externalities, and market dynamics, for example, through mechanisms such as the nationwide implementation of tiered electricity pricing for energy-intensive sectors.

Second, a systematic and robust performance evaluation framework must be established. The core of this system lies in developing a scientific, equitable, and dynamic mechanism for allocating and managing carbon emission budgets. On the one hand, implementation must follow a "place-based and evidence-based" approach. This model must integrate regional development stages (per capita GDP, industrialization levels), structural characteristics (share of carbon-intensive industries, renewable energy potential), resource endowments (forest carbon sinks, CCUS geological suitability), and mitigation potential (technology substitution costs). For instance, provinces in China's western region—which are rich in renewable resources but economically less developed—could be granted more flexible initial total budgets paired with stringent intensity-reduction mandates. This supports "decarbonized growth" via green power industries. Conversely, major industrial provinces with structural rigidities should face more challenging budgets, complemented by technical and financial assistance, reflecting the principle of "common but differentiated responsibilities" (CBDR) at the sub-national level. Furthermore, these budget cycles should align with China's FYP periods, with potential mechanisms for inter-temporal "banking and borrowing" to enhance flexibility. On the other hand, the evaluation must be anchored in a system of "strong incentives and hard constraints" to ensure a decisive "baton effect." The fulfillment of "Dual Control" targets for carbon emissions should serve as a decisive "one-vote disqualification from merit evaluation" criterion in the comprehensive assessment and promotion of leading officials. Its weighting should be increased to align with traditional core indicators such as GDP growth and social stability; in ecologically sensitive zones, a "one-vote disqualification" policy for environmental failure should be strictly enforced. Exemplary regions should receive preferential access to green special transfer payments, ecological compensation funds, and higher quotas for local government green bonds. Conversely, regions that exceed their budgets should face punitive measures, such as deductions from transfer payments and the suspension of fiscal subsidies for energy-consuming projects.

Third, advancing enterprise-level carbon management is essential to activate market signals and strengthen endogenous momentum. As enterprises are the ultimate executors of

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decarbonization, the regulatory framework must be upgraded from managing "key energy-consumers" to overseeing "key carbon-emitters." This transition imposes compulsory requirements for periodic carbon accounting and reporting, with carbon performance metrics—such as carbon intensity per unit of product and carbon productivity—serving as core regulatory indicators. China's National Carbon Emissions Trading System (ETS) remains the central policy instrument. By gradually tightening free-allowance allocations, expanding sectoral coverage, and introducing paid allocation and auction mechanisms, the system can ensure carbon prices accurately reflect abatement costs, generating sustained and robust price signals. Simultaneously, financial institutions should use corporate carbon performance to develop differentiated green credit, bond, and insurance products, ensuring that low-carbon performers receive lower financing costs and creating a market-based, self-reinforcing incentive loop.

Fourth, rigorous project-level carbon evaluation must be implemented to strengthen source-based entry controls and prevent high-carbon lock-in. To achieve carbon peaking, it is imperative to strictly prevent the "lock-in effect" associated with new high-carbon investments at the incremental source. This requires elevating life-cycle carbon-emission assessments to the status of Environmental Impact Assessments (EIA) and Energy Conservation Reviews, establishing them as a mandatory precondition for the approval of all new construction, expansion, and major technological renovation projects in China. For major projects whose carbon intensity exceeds advanced industry benchmarks, or whose implementation would cause regional carbon emissions to exceed allocated budgets, a "one-vote disqualification" mechanism should be applied. Alternatively, the projects must be mandated to implement equivalent, enforceable emission-reduction substitution schemes.

Fifth, a product carbon footprint system must be established to drive the transformation of supply chains and consumption patterns. Market demand is the primary catalyst for the green transition. Therefore, China must accelerate the development of a unified, authoritative framework for carbon footprint accounting, certification, and labeling that covers major industrial and consumer products. By quantifying total emissions across the entire life cycle—from raw material acquisition and production to transportation, use, and disposal—and conveying this data through intuitive labeling, invisible carbon impacts are rendered tangible to market selection. This system will incentivize large-scale purchasers and brand owners to prioritize low-carbon options, thereby transmitting upstream emission-reduction pressure through green supply chain management and fostering coordinated decarbonization across the entire value chain. Furthermore, the government can play a leading role in cultivating this market through green public procurement and targeted consumption subsidies.

Collectively, these five dimensions are mutually reinforcing and sequentially integrated, forming a rigorous institutional network for China's green governance. As such, this framework ranges from macro-level target decomposition to micro-level product guidance, bridging the gap between administrative performance evaluation and market-driven incentives. Furthermore, it encompasses the full spectrum of management from source-based prevention to full life-cycle oversight.

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4.2 Leveraging New Quality Productive Forces as the Core Engine: Strengthening "Green-Intelligent-Resilient" Empowerment

Technological innovation serves as the "engine" of China's green transition. Amid intensifying global competition in green technologies, the development of new quality productive forces must be prioritized to ensure autonomous control of core technologies and their deep integration into industrial upgrading. Guided by a strategic framework of "Green, Intelligent, and Resilient" (GIR) integration, China must achieve critical breakthroughs across several key pathways during the 15th FYP period.

First, China must construct a "smart and resilient" new-type energy system as the primary arena for Green-Intelligent-Resilient (GIR) synergy. From a "green" perspective, the central task is to substantially increase the share of non-fossil energy in the national energy mix, while driving coal consumption to its peak, and then reducing it steadily. Regarding the "intelligent" dimension, priority should be given to building a new-type power system centered on smart grids and efficient source-grid-load-storage interaction; by leveraging artificial intelligence to forecast renewable energy output and optimize dispatch strategies, China can enable the "plug-and-play" integration and aggregated management of massive distributed energy resources. From a "resilient" perspective, it is essential to simultaneously develop long-duration regulation capabilities, such as large-scale energy storage and hydrogen energy, to bolster the power system's capacity to withstand extreme weather and cyberattacks, thereby fostering a security paradigm of multi-energy complementarity and regional mutual assistance. In parallel, China's energy governance and market mechanisms must be reformed with a focus on digitalization and resilience to ensure a market system capable of accommodating a high share of renewable energy.

Second, China must implement a "Precision-Intelligent" dual control system for carbon emissions, aligning green ambitions with intelligent execution and robust safeguards. To achieve a comprehensive transition to the "Dual Control" of carbon emissions, smart technologies must be integrated with resilient governance principles. Under the "green" objective, China should establish a unified, nationwide carbon accounting and performance assessment system covering all regions, sectors, and enterprises. Regarding "intelligent" execution, the government should leverage the Internet of Things (IoT) and blockchain to build real-time, trustworthy carbon-monitoring networks and predictive models, enabling a transformative shift from retrospective results-based accounting to proactive, process-oriented intelligent control. Finally, to provide "resilient" safeguards, China's carbon market must incorporate effective price-stabilization mechanisms to manage volatility, and differentiated transition pathways for diverse regions and industries are essential to avoid the systemic risks of a "one-size-fits-all" approach, thereby ensuring a smooth and orderly low-carbon transition.

Third, China must cultivate "integrated and efficient" green and low-carbon industries, characterized by an intrinsic green essence, intelligent operational processes, and systemic resilience. As an inherent requirement for developing new quality productive forces, this industrial transformation focuses first on "greenness" as its core, aiming to build a structure characterized by high technological intensity, low resource consumption, and minimal environmental impact. Second, "intelligence" defines the transformation process. By integrating the Industrial Internet,

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artificial intelligence, and digital twins, China can achieve flexible, fine-grained production that significantly enhances energy and material efficiency. Finally, "resilience" serves as a critical systemic attribute. This involves diversifying industrial and supply chain layouts and strengthening backup capacities in critical sectors. By expanding resource recycling and circular-economy industries to reduce external resource dependence, China's green industrial system can develop robust shock-absorption and rapid-recovery capabilities necessary to withstand global disruptions.

Fourth, China must advance "digital-twin-enabled" ecological and environmental zoning regulation, characterized by green baselines, intelligent tools, and spatial resilience. As the cornerstone for optimizing territorial development and protection, this framework first establishes "greenness" as the spatial baseline by stringently enforcing Ecological Protection Red Lines within the "Three Zones and Three Lines" framework (which defines urban, agricultural, and ecological spaces, along with three mandatory control boundaries (red lines for ecological protection, permanent basic farmland, and urban development boundaries). Second, "intelligence" serves as a management tool. By constructing digital twins of river basins or regions, China can dynamically simulate and assess the environmental impacts of development activities, thereby enabling intelligent optimization and real-time updating of spatial regulation schemes. Finally, "resilience" constitutes the spatial objective. By aligning the distribution of productive forces with natural ecosystem patterns, zoning regulations protect and enhance ecosystem integrity and connectivity. In doing so, it strengthens the long-term ecological security of the national territorial space and provides a sustainable carrying capacity for future development.

It must be further emphasized that national territorial space is the essential carrier of development, and its utilization patterns directly determine the upper limits of resource and environmental carrying capacity. During the 15th FYP period, it is imperative to ensure the rigorous enforcement of the ecological and environmental zoning system, positioning it as both a "hard constraint" and a strategic "proactive initiative" in balancing development with protection. The core task is to deepen the application of the "Three Lines and One List" framework—comprising ecological protection red lines, environmental quality bottom lines, resource utilization ceilings, and ecological environmental access lists—by fully integrating these metrics into the "Single Map" of national territorial spatial planning. This framework must function as a mandatory criterion for regional industrial layouts, structural adjustments, resource development, urban construction, and the siting of major projects. On this basis, China should implement differentiated spatial development strategies to guide productive forces toward regions with ample environmental capacity, favorable market conditions, and robust development potential—thereby fostering a green, low-carbon, and high-quality development paradigm aligned with the nation's carrying capacity.

4.3 Expanding Global Collaboration to Shape a Favorable External Environment and New Competitive Advantages

First, China should proactively articulate and demonstrate the global significance of its green development. The international impact of China's green transition lies in its profound redefinition of "latecomer advantage," demonstrating that developing nations possess immense "leapfrog

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potential" in their developmental trajectories—far beyond conventional technological catch-up. Traditional theories of latecomer advantage emphasize technical imitation, capital inflows, and structural transfers, often tacitly accepting a high-pollution industrialization path as an inevitability. China's experience reveals that the latecomer advantage lies in leveraging it, harnessing the latest technological revolutions (such as renewables and digitalization) and frontier governance concepts (such as Ecological Civilization) to forge an entirely new path deliberately. This is the essence of China's strategy to "overtake on the curve" and "change lanes for development." In the energy sector, for instance, China did not follow a strictly linear progression from coal to oil and gas before reaching renewables. Instead, by leveraging robust industrial coordination and massive market scale, China pursued the clean utilization of coal while simultaneously building the world's most comprehensive and competitive supply chains for photovoltaics, wind power, and power batteries—thereby capturing the "commanding heights" of the global energy transition. This "path-creating" latecomer advantage offers a realistic alternative for other developing nations to escape the "pollute first, treat later" trap; it proves that environmental quality need not be sacrificed for primary industrialization, as green elements can be embedded directly into the growth engine from the outset. For developed economies, China's model dismantles the false dichotomy between "modernization" and "Westernization." As such, this demonstrates the socio-political and economic viability of a green development path for a nation with a massive population (Huang, 2022). While some Western environmental theories posit a static trade-off between ecological protection and economic growth—assuming only high-income societies can afford "green costs"—China's approach remains rooted in the reality of a developing giant with 1.4 billion people. China's green transition is never "environmentalism for its own sake" divorced from development; rather, it is anchored in the conviction that "lucid waters and lush mountains are invaluable assets," and focuses on realizing the value of ecological products to achieve high-quality, inclusive growth.

Second, China must persistently advance the Green Belt and Road Initiative (BRI) as a flagship platform for leading global ecological governance. China has actively promoted green infrastructure, renewable energy, and sustainable finance cooperation along the Belt and Road Initiative, thereby empowering partner developing countries to accelerate their low-carbon transitions. The BRICS Partnership on New Industrial Revolution (PartNIR) has broad global representativeness. It serves as a core platform during the 15th FYP period for China to establish BRICS industrial capacity centers and to guide the evolution of this partnership. Its collaborative model also provides a powerful demonstration and leading example for the rise of the Global South. Simultaneously, China occupies a pivotal position in shaping global green industrial and supply chains. Dominating world markets in photovoltaic modules, wind power equipment, and new energy vehicles (NEVs), China supplies premium green products worldwide and supports partner nations in building their own green industries through technology transfer, joint capacity cooperation, and industrial collaboration. These multifaceted contributions have made "green" the defining foundation of international cooperation—a legacy that must be further strengthened, institutionalized, and amplified throughout the 15th FYP period.

Third, as green transformation advances in an open global context, China must further demonstrate its global responsibility and leadership by coordinating domestic and global priorities.

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As a key participant, contributor, and leader in global ecological civilization, China should adopt an increasingly proactive stance in global environmental governance throughout the 15th FYP period. This involves firmly upholding the UNFCCC and the Paris Agreement as the primary multilateral channels while honoring its "Dual Carbon" commitments through concrete actions that bolster global climate leadership (Zhang et al., 2021). Concurrently, China should leverage multilateral platforms—including the G20, BRICS, the Shanghai Cooperation Organization (SCO), and the Belt and Road International Green Development Coalition—to turn its vast market scale and industrial strengths into influence over international rules and standards in green infrastructure, energy, and finance. In particular, amid the rise of unilateralism and "green trade barriers," China must employ a strategy that combines cooperation with principled countermeasures. On the one hand, it should strengthen bilateral and regional cooperation in green technology, trade, investment, and promote mutual recognition. On the other hand, it must engage in principled, advantageous, and measured countermeasures against the instrumentalization of climate issues that seek to undermine China's legitimate development.

In conclusion, China's comprehensive green transition strategy during the 15th FYP period is poised to cultivate a deep-seated and novel form of competitive advantage—one that transcends the zero-sum logic of traditional geopolitical rivalries. Ultimately, China's green transition will serve as a "stabilizing anchor" and a "source of momentum" in major-country strategic interactions, anchoring global cooperation while driving the next wave of sustainable development.

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