



ENERGY FOUNDATION

能源基金会

Electrification Task Force Strategy: Electrifying China's Carbon Neutral Future

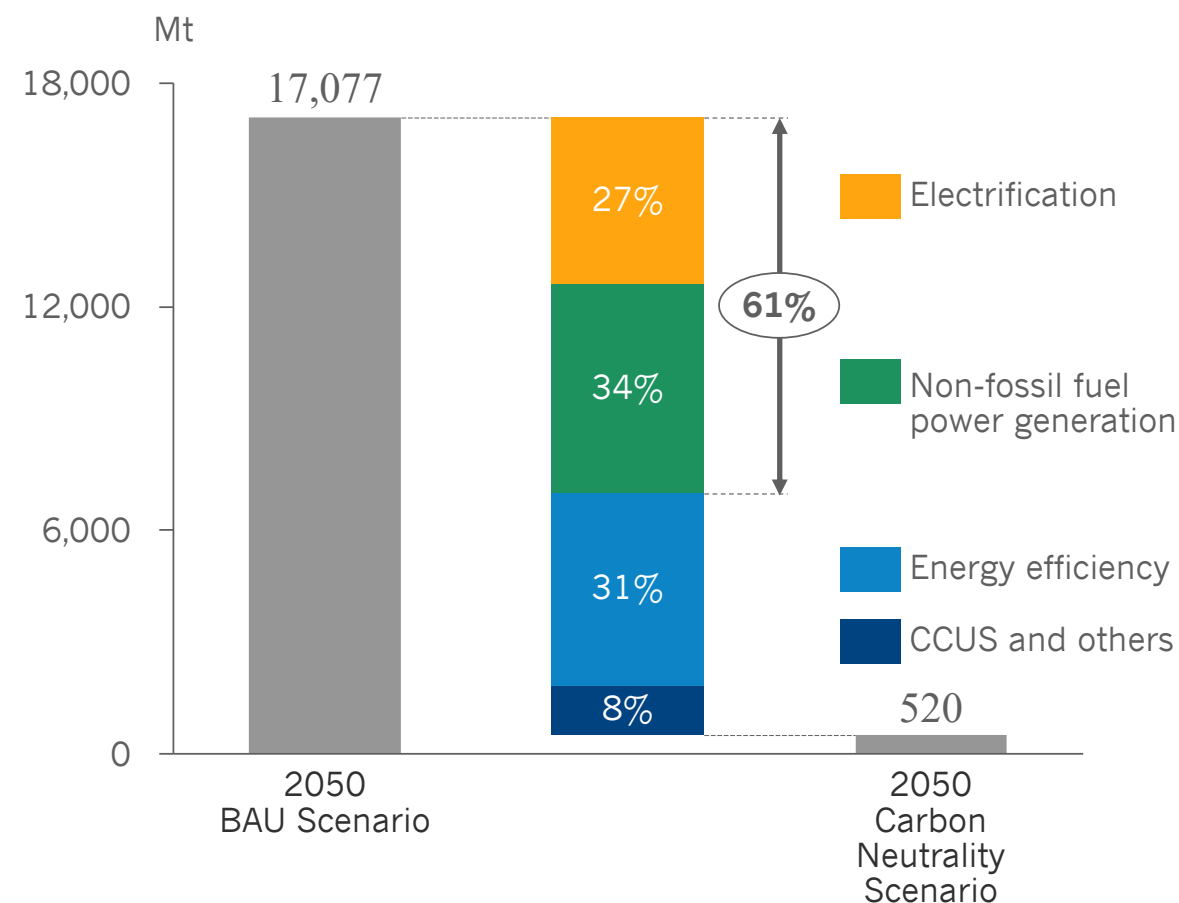
This strategy was presented to EF China board in Dec 2021, and subjects to regular updates.

Overview

- ① Role of Electrification Towards Carbon Neutrality: Challenges and Opportunities
- ② Vision and Goals of EFC's Electrification Strategy
- ③ Key Initiatives
- ④ Implementation and Roll Out

Role of Electrification Towards Carbon Neutrality

- The electrification across all sectors-industry, transportation and building sectors-alongside the rapid decarbonization of power supply is an important pillar of China's strategy for achieving carbon neutrality, contributing to **61%** of the overall carbon mitigation beyond BAU.
- It is not only because it will be feasible to achieve substantial emissions reductions in power sector more quickly than in other sectors. Moreover, electrification offers the opportunity to curb and eventually reduce final energy consumption due to significantly higher efficiencies in many applications.

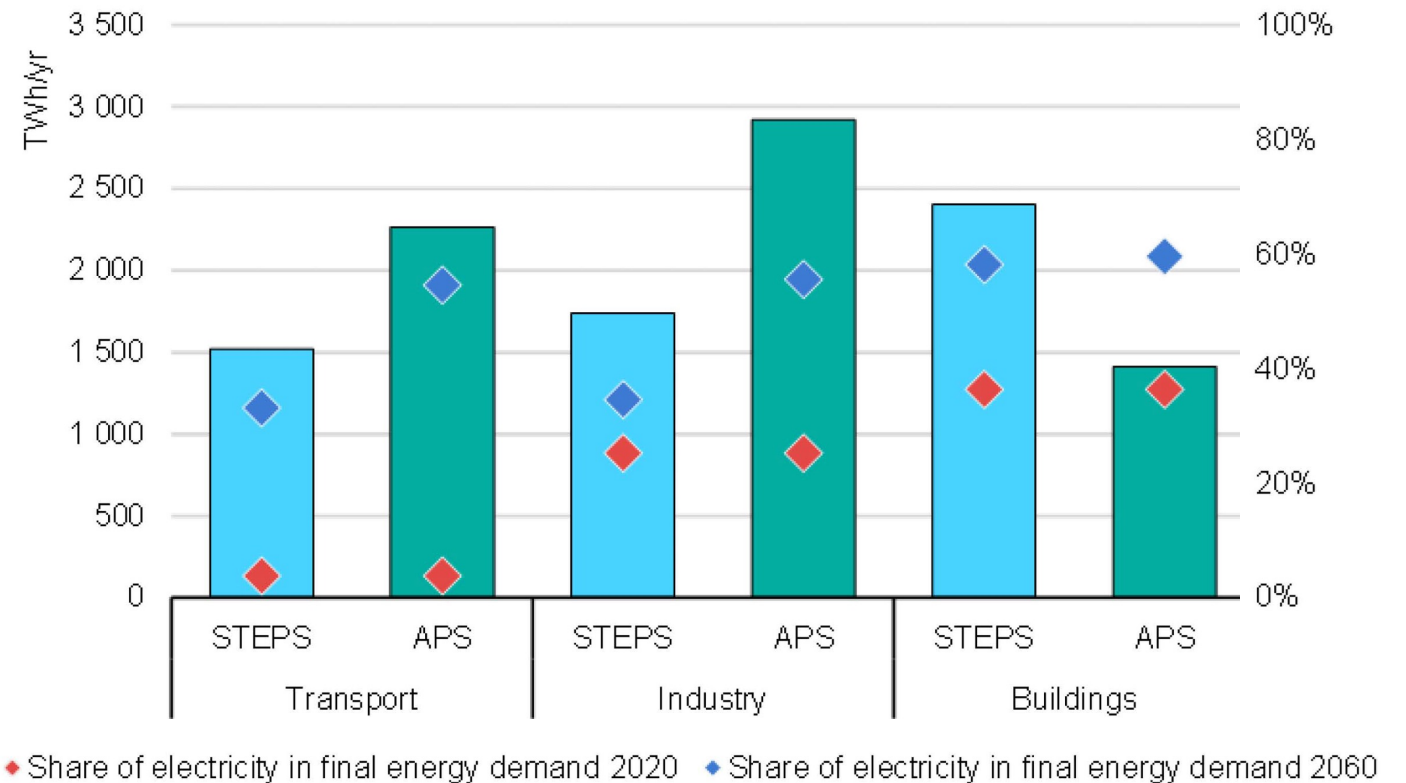


* Definition of electrification rate: share of electricity consumption in total final energy consumption

Source: PECE_LIU model results from RUC and HITSZ

Role of Electrification Towards Carbon Neutrality

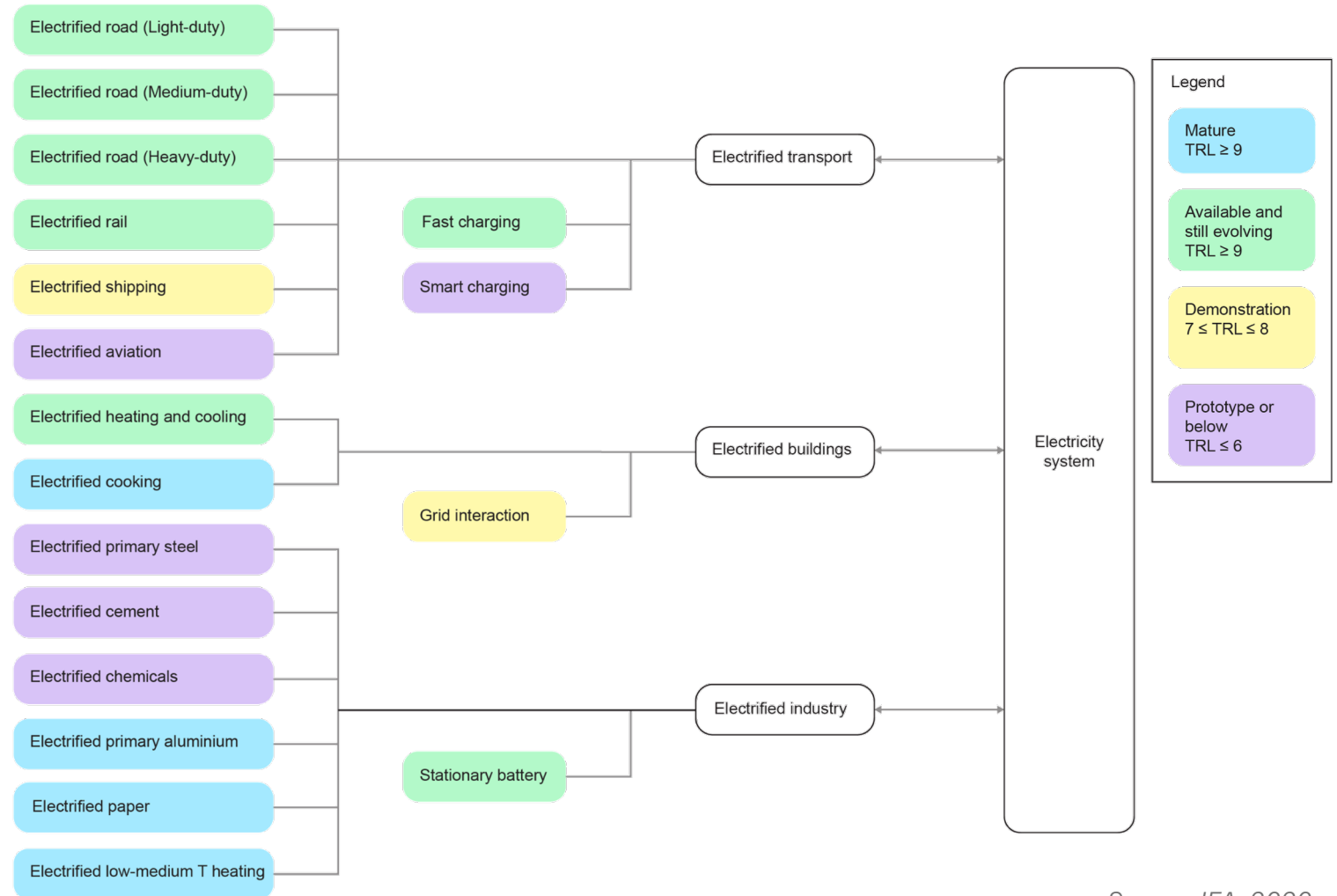
- China has experienced fast electrification in the past, with the electrification rate reaching 25.5% in 2018.
- But there is still a big gap (up to 51 percentage points) in electrification rate between China and advanced economies' end-use industries.
- China's electrification rate may reach around 60% by 2050 to achieve carbon neutrality which will then result in huge increase in electricity demand (EFC, 2020).
- Electricity accounts for more than half of transport and industry energy demand, 60% of buildings final demand.



Source: IEA, 2021. APS = Announced Pledges Scenario (carbon neutrality scenario); STEPS = Stated Policies Scenario.

Role of Electrification Towards Carbon Neutrality

- Promoting the goal of electrification in the context of carbon neutrality requires **comprehensive and cross-sectoral integration**.
- Major barriers exist, requiring **major technological breakthroughs, tremendous infrastructure investment, and policies and regulations to promote scaling up**.
- Most electric technologies critical for carbon neutrality are on the market today, but further innovation is needed to make them viable for broader applications, particularly in batteries and heavy industrial processes



Source: IEA, 2020

Overall Challenges and Risks of Electrification

- Increased electricity demand, adding more pressure on the growth of fossil fuel electricity generation
- Huge demand for grid flexibility
- Possibly enlarged peak-to-valley difference of power load

Major challenges to the power system:

Major change in end-use sectors:

- Adjustment of key production processes and supporting infrastructure
- Stranded assets of existing infrastructure.
- Immaturity of advanced electrification technologies
- Affordability concerns, cost sharing and just transition problems

Lag of electrification supporting institutions, mechanisms, policies and technical standards

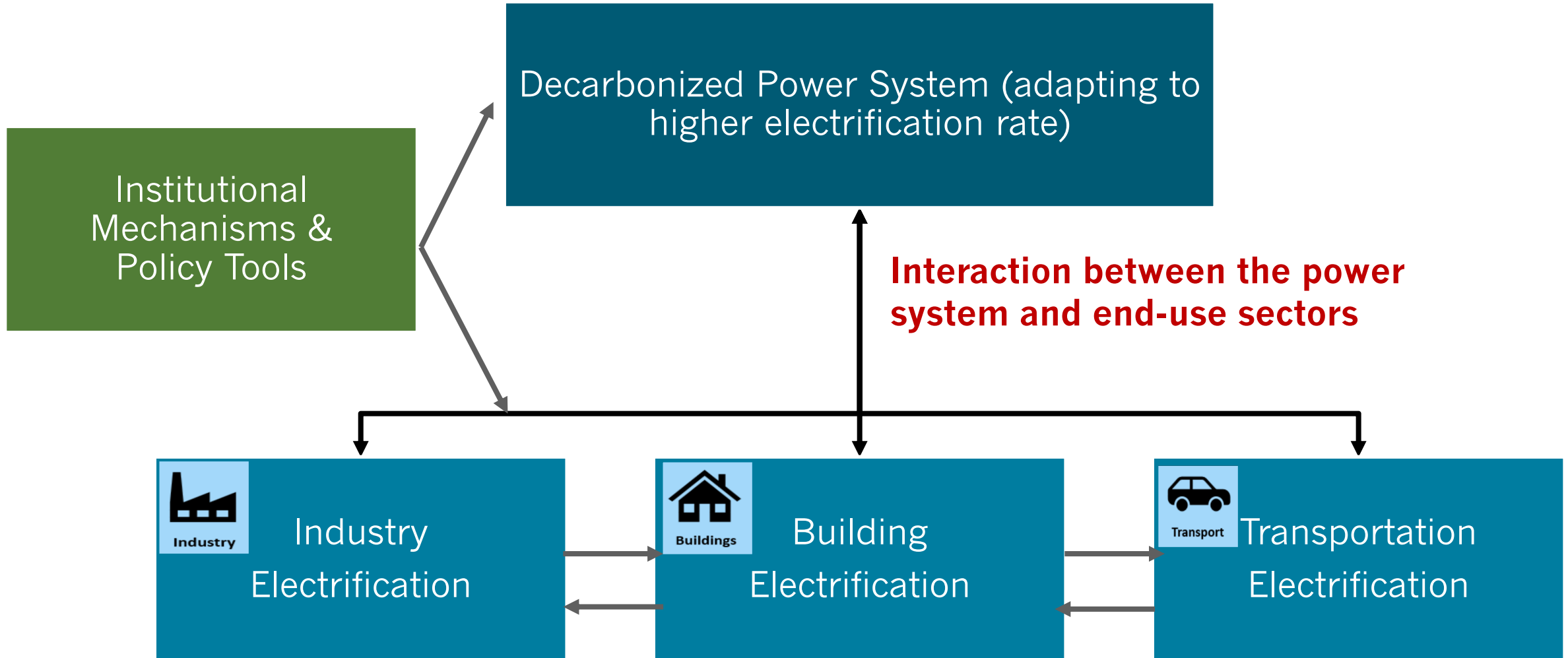
Push back from vested interest groups

Vision and Goals

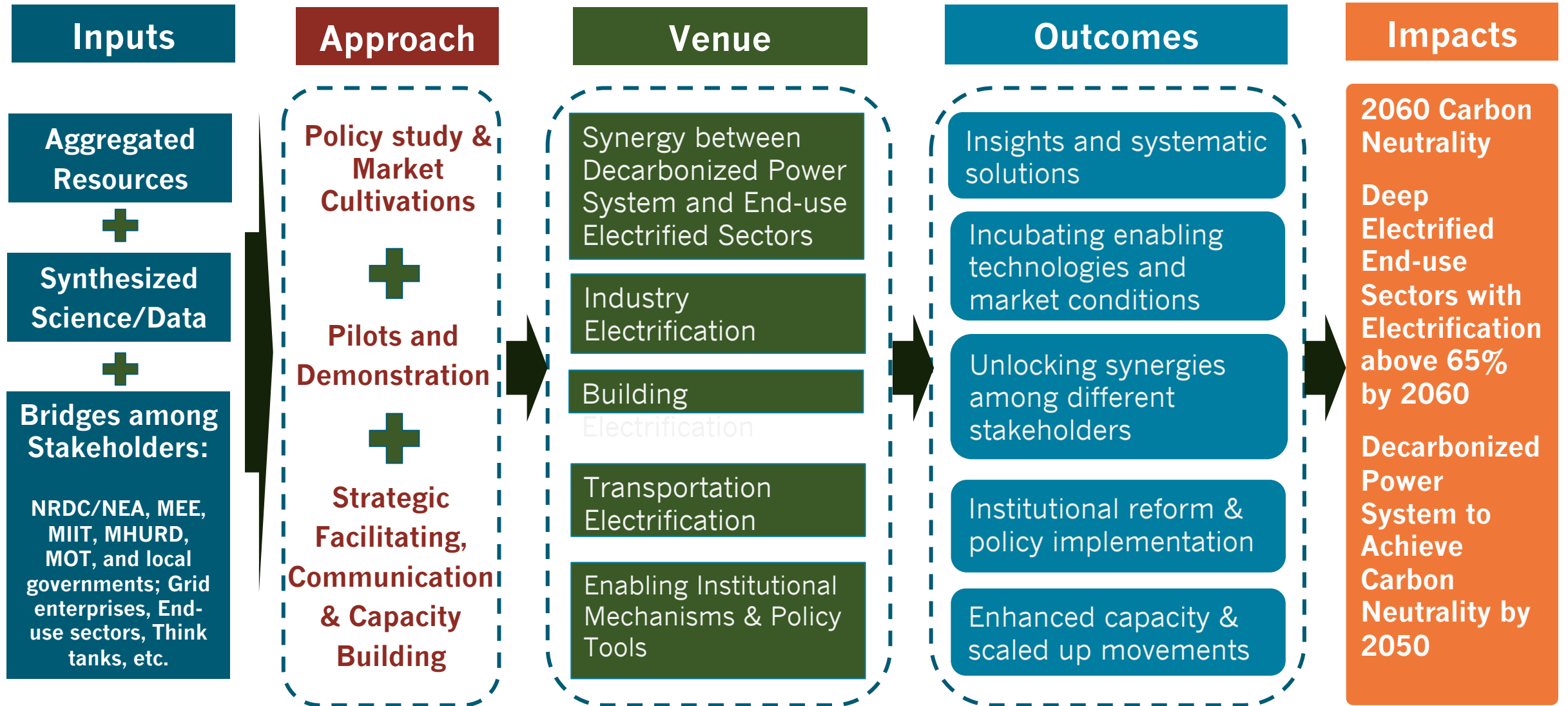
Accelerating Deep Electrification Combined with Power Decarbonization towards China's Carbon Neutrality via Healthy Interaction between Grid and End-Use Sectors

	2020	2025 EFC goals	2035 EFC goals	2050 EFC goals
CO ₂ emissions reduction from the power sector (% , based on 2015 level)		+20%	-20%	-100%
Overall Electrification Rate (% , direct equivalent)	25	30	45	65
Annual electricity consumption per capita (kWh)	5322	6300	8000	14000

Overall Framework

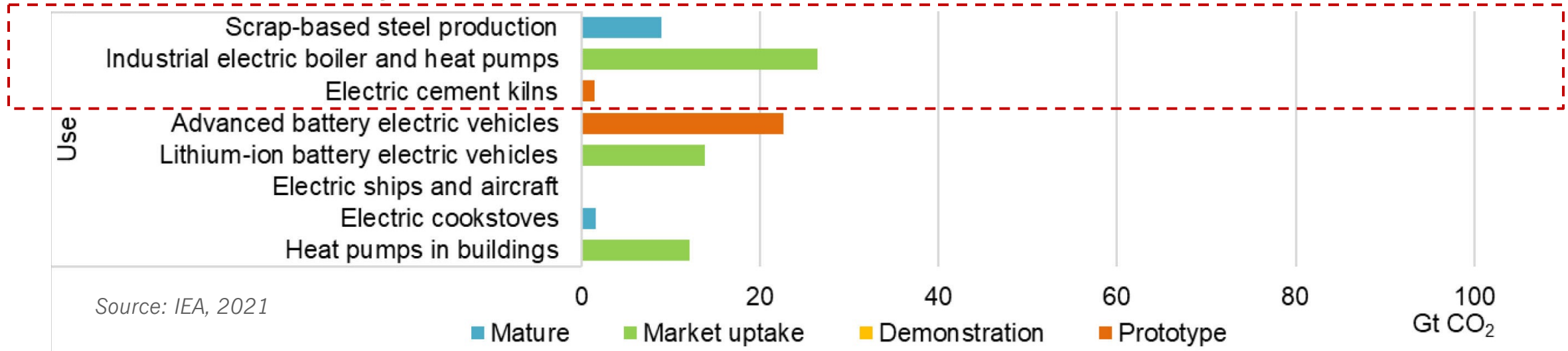


Theory of Change



Initiative I: Industry Electrification

Cumulative CO2 emissions avoided by selected electricity technologies by maturity category in China towards carbon neutrality, 2020-2060



Challenges

- Industry is the most challenging sector to electrification because of its unique dependencies on fossil fuels for both fuel and feedstocks, and because of the lack of cost-effective substitution (in contrast to transport, where ICE vehicles can be replaced by already available EVs).
- For high-temperature industrial processes, there is no significant efficiency gain from a shift to electricity.

Opportunities

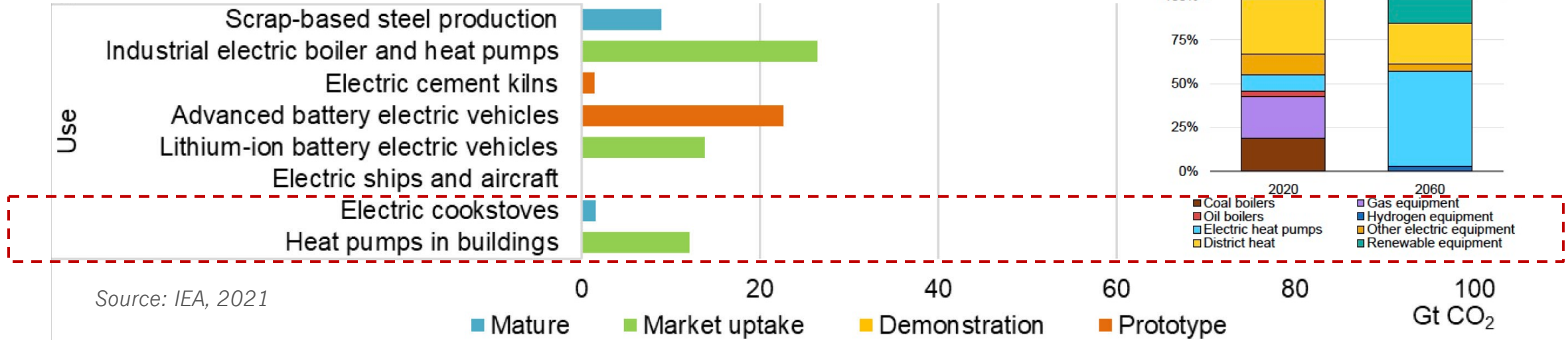
- Direct use of electricity grows to satisfy the demand for low- and medium-temperature heat, particularly in light industries for manufacturing, heat pumps and other electric heating technologies.
- Electric motors in the light industry sectors will grow rapidly.
- In steel and aluminum industries, secondary production (using scrap metal) is an important way for electrification.

Initiative I: Industry Electrification

- **Promote Industrial re-structure and upgrading**
- **Enhance the production process adjustment and electric substitution technology**
 - Piloting and disseminating short-process electric furnace steelmaking
 - Piloting and disseminating electric heating furnaces for building materials such as cement electric furnaces, glass electric melting furnaces, ceramic electric furnaces, etc.
 - Piloting and disseminating industrial electric boilers, electric furnaces, electric metallurgical furnaces, industrial heat pumps based on waste heat source, electric cold storage, etc.
- **Accelerate RD&D of advanced industrial electrification technology**
 - Promote induction or microwave heat technology
 - Promote direct reduced iron technology based on green hydrogen
 - Promote infrared and ultraviolet heating technology for process heating
- **Develop enabling policies and market environment**
 - Adopt procurement policies that consider the carbon profile when making purchasing decision.
 - Adopt tax and subsidy policies that encourage investment in electrified thermal technologies.
 - Adopt policies that price carbon emissions at a level that supports electrified technologies.
 - Develop technology standards and adopt electricity rate designs that encourage electrification.
 - Adopt renewable portfolio requirements for thermal energy.

Initiative II: Building Electrification

Cumulative CO2 emissions avoided by selected electricity technologies by maturity category in China towards carbon neutrality, 2020-2060



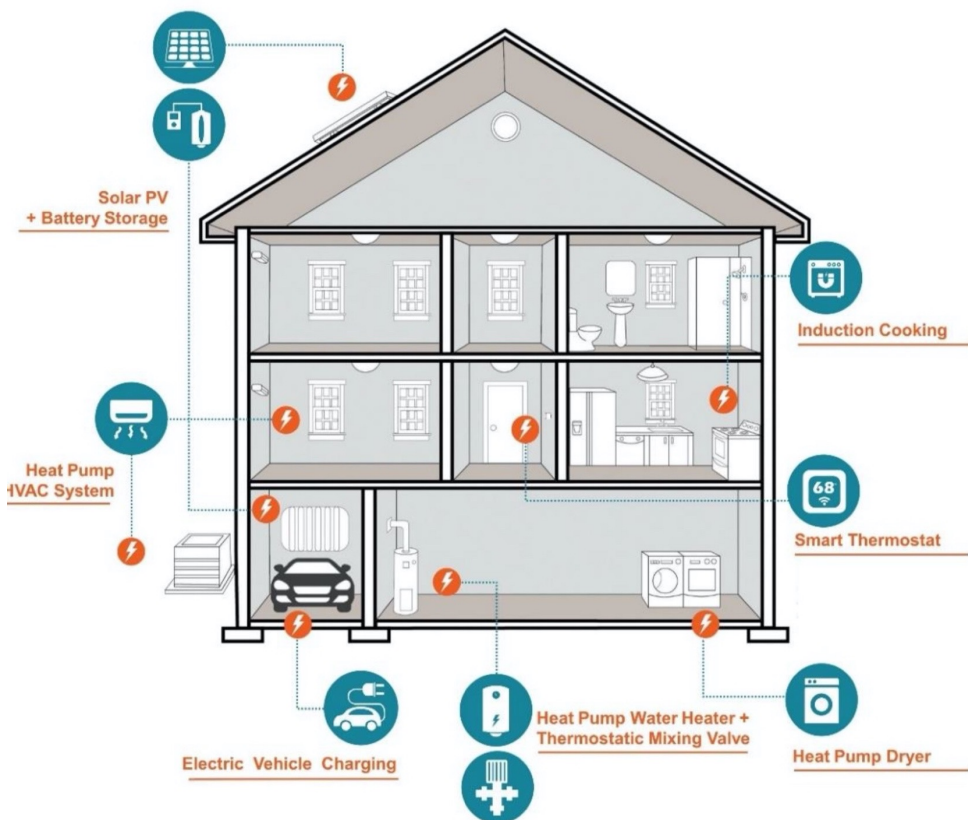
Challenges

- Some electrification measures need further improved for wide adoption, e.g. conventional ASHPs are not applicable for space heating in cold regions for poor energy efficiency performance.
- The higher investment cost of electrification measures have significantly hindered the diffusion in the market.
- Another challenge is people's cultural, e.g. preference on high temperature cooking.

Opportunities

- As buildings and related HVAC systems have a rather long lifetime, it is currently a critical time window to adopt new electrification measures in buildings as China is experiencing the construction boom to avoid lock-in effects.
- Promoting electrification in rural residential buildings could greatly improve the standards of living of rural households and help to avoid indoor/outdoor air pollutions.

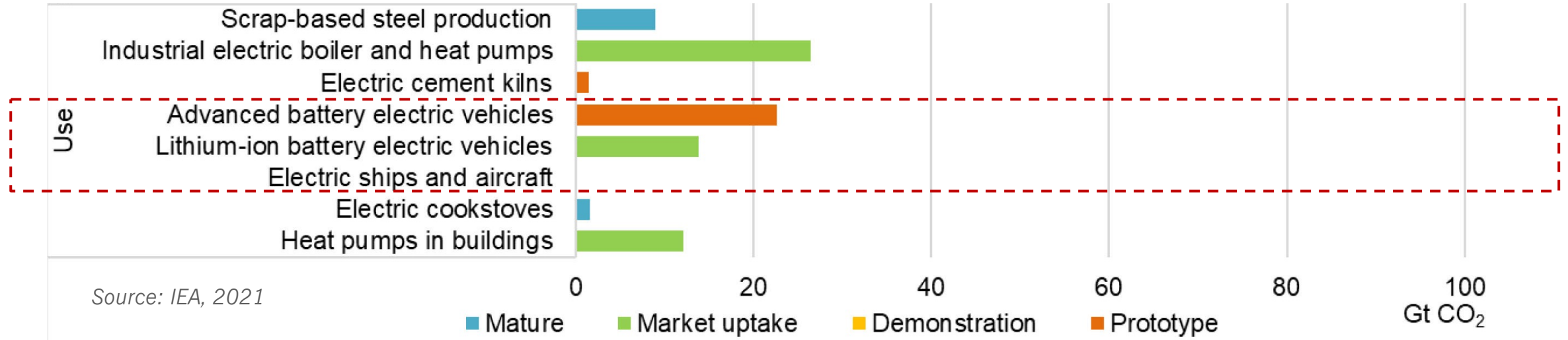
Initiative II: Building Electrification



- **Accelerate the development and diffusion of electrification measures, including**
 - using more electric space heating in northern urban China;
 - adopting electric space heating in rural households ;
 - replacing gas/coal/biomass cooking stoves with electric cooking stoves; and
 - using more electric water heaters instead of gas ones for producing domestic hot water.
- **Promote enabling environment for building electrification**
 - Promote the governments at different levels to develop long-term plans of electric space heating.
 - Include heat pump into public procurement
 - Establish regulation for controlling the commercial license of related equipment manufacturers, parts suppliers, and project contractors to ensure the quality of implemented projects
 - Promote financial incentives, including favorable electricity price, free water charge for GSHP projects, subsidies to owners and operators, soft loans, etc.
 - Extensive publicity programs to change mindsets and behavior

Initiative III: Transportation Electrification

Cumulative CO2 emissions avoided by selected electricity technologies by maturity category in China towards carbon neutrality, 2020-2060



Challenges

- Despite leading the world in electrification of road transport, oil products and natural gas still provide about 95% of China's transport final energy demand today. Complete shift to EV requires systematic change, from behaviour to industrial chain, supply chain and infrastructure.
- Further innovation is needed for long-distance transport. In aviation, prototypes of electric planes are far from commercial.

Opportunities

- China is taking leading role in EV industry. And there is growing support for passenger road electrification from both industry and subnational governments.
- Electrification of transport could provide extra benefits as energy security, air quality and climate change, and would also be an ideal use of renewable power, given the variable output of sources such as solar and wind.

Initiative III: Transportation Electrification

- Accelerate electrification towards zero emission road transport**

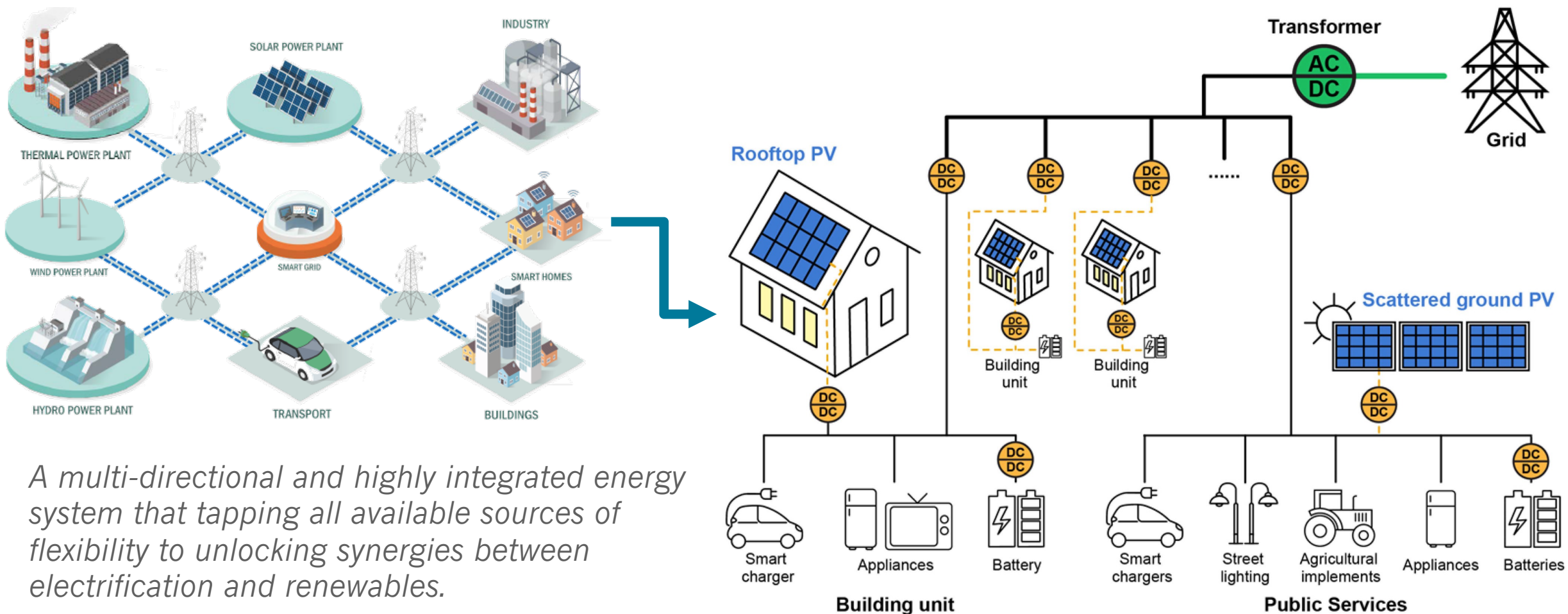
National Policy Options for Freight Road Electrification	Subnational Policy Options for Accelerating Passenger Road Electrification
Zero emission vehicle freight sales requirements/targets	Car license plate restrictions, traffic restrictions
Low carbon fuel standard for trucks	Public or municipal fleet electrification targets
Weight exemptions for ZEVs (heavy-duty vehicles)	Direct purchase subsidies and subsidized charging infrastructure use
Direct incentives	ZEV direct access and waivers for zero-emission zones
Direct and utility investments in EV charging	Preferential parking policies

- Support the coordinated and effective development of charging infrastructure**

- targeting high-value, high-use charging segments such as public and logistics fleets in public charging infrastructure roll-out to maximize charger utilization
- Priority permitting and guarantees of land, energy and labor to help reduce regulatory and bureaucratic challenges to charging station siting and development.

- Promote rail transit and further enhance R&D and explore solutions for electrifying and decarbonising ship and aviation**

Initiative IV: Synergy between Decarbonized Power System and End-use Electrified Sectors



A multi-directional and highly integrated energy system that tapping all available sources of flexibility to unlocking synergies between electrification and renewables.

Source: IEA, 2019/2021

Initiative IV: Synergy between Decarbonized Power System and End-use Electrified Sectors

- **Promote smart demand side response management, such as smart charging, V2G and VPP to reduce the peak-load grid costs and avoid excessive new investment in power distribution**
 - The most significant negative impacts of electrification could be unprecedented increases in peak demand relative to average demand. For example, EV charging may raise daily peaks substantially, while heat pumps could increase the seasonal peak (such as winter in European countries). This problem can be solved through smart management of demand. For example, EVs smart charging would provide further flexibility to the grid saving between USD 100-280 billion investment in new electricity infrastructure. In addition, drawing power from plugged-in vehicles (V2G) could even provide extra flexibility.
- **Conduct comprehensive pilots to scale up innovative and comprehensive solutions as PDEF to gain systematic benefits**
 - Including providing technical solutions, develop standards and supporting policies, enhance coordination among different stakeholders, pilots in selected locations, explore business mode, etc.
- **Unlocking synergies among sectors through better coordination**
 - Involvement of local stakeholders, urban planners, distribution operators and central regulators to decide on roll-out of EV charging stations
 - Explore relocating energy-intensive industries to sites with low-cost renewable power.

Initiative V: Institutional Mechanisms & Policy Tools

- **Develop a long-term vision and implementation roadmap of the role of electricity in China's energy system**
- **Plan for building or expanding electrification Infrastructure**, including transmission and distribution grids, charging networks, and district heating and cooling systems, etc.
- **Promote enabling regulations and policy tools**
 - Deepen electricity market reform and promote market and price-based instruments such as power market reform, carbon pricing and retail pricing reform
 - Remove barriers to innovative technologies or ownership models.
 - Provide incentives or funds or business mode for widespread adoption and use of heat pumps, electric boilers, motors and other appliances.
- **Enhancing Institutional and policy coordination among sectors**
 - Improvements in both vertical (national, provincial, and local) and horizontal (cross-ministerial) policy coordination, to address and overcome regulator silos.

Joint efforts within EFC to Implement the strategy

Initiatives	CPP	CIP	LCCP	CTP	CEMP	LCEG	COMM	Task-force
Industry electrification		Industry electrification strategy and pilots				Electrification demand of industrial transformation	Narrative building	<ul style="list-style-type: none"> • Integrated electrification strategy, • linkage between end-use sectors • Interaction between end-use sectors and grid
Building electrification			Building electrification strategy and pilots		Rural coal-to-power conversion	Electrification demand for service industry and living improvement	Narrative building and Consumption patterns	
Transportation electrification				Transportation electrification strategy and pilots			Narrative building and Consumption patterns	
Synergy between Power System and End-use Sectors	Interaction between grid and end-use sectors	Industry demand response	PEDF	V2G				
Institutional Mechanisms & Policy Tools	Electricity market/price mechanism	Industrial sector policies	Building sector policies	Transportation sector policies	Environmental policies	Institutional mechanism, policy coordination		



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