



China's Innovation and Energy Policy

CHEN Jin

Professor of Innovation Management & Policy
School of Economics and Management
Tsinghua University

Global Innovation at a Glance

(Global Innovation Index 2018)

**Global Innovation Index 2018: China Cracks Top 20.
Top Rankings: Switzerland, Netherlands, Sweden,
UK, Singapore, U.S.**

Global Innovation Index 2018 rankings

**GLOBAL
INNOVATION
INDEX 2018**
Energizing the World with Innovation

Country/Economy	Score (0–100)	Rank	Income	Rank	Region	Rank	Efficiency Ratio	Rank	Median: 0.61
Switzerland	68.40	1	HI	1	EUR	1	0.96	1	
Netherlands	63.32	2	HI	2	EUR	2	0.91	4	
Sweden	63.08	3	HI	3	EUR	3	0.82	10	
United Kingdom	60.13	4	HI	4	EUR	4	0.77	21	
Singapore	59.83	5	HI	5	SEAO	1	0.61	63	
United States of America	59.81	6	HI	6	NAC	1	0.76	22	
Finland	59.63	7	HI	7	EUR	5	0.76	24	
Denmark	58.39	8	HI	8	EUR	6	0.73	29	
Germany	58.03	9	HI	9	EUR	7	0.83	9	
Ireland	57.19	10	HI	10	EUR	8	0.81	13	
Israel	56.79	11	HI	11	NAWA	1	0.81	14	
Korea, Republic of	56.63	12	HI	12	SEAO	2	0.79	20	
Japan	54.95	13	HI	13	SEAO	3	0.68	44	
Hong Kong (China)	54.62	14	HI	14	SEAO	4	0.64	54	
Luxembourg	54.53	15	HI	15	EUR	9	0.94	2	
France	54.36	16	HI	16	EUR	10	0.72	32	
China	53.06	17	UM	1	SEAO	5	0.92	3	
Canada	52.98	18	HI	17	NAC	2	0.61	61	
Norway	52.63	19	HI	18	EUR	11	0.64	52	
Australia	51.98	20	HI	19	SEAO	6	0.58	76	

Global Innovation at a Glance

(Bloomberg Innovation Index 2017&2018)



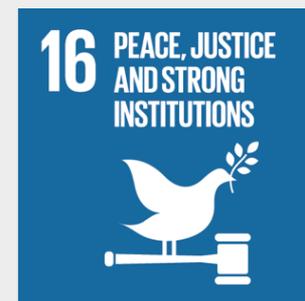
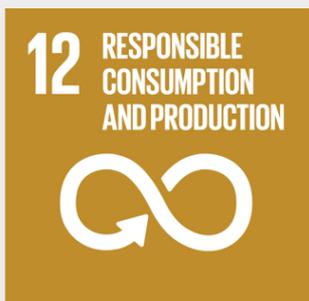
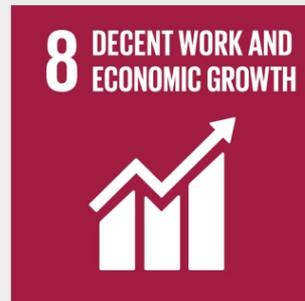
2018 rank	2017 rank	YoY change	Economy	Total score	R&D intensity	Manufacturing value-added	Productivity	High-tech density	Tertiary efficiency	Researcher concentration	Patent activity
1	1	0	S. Korea	89.28	2	2	21	4	3	4	1
2	2	0	Sweden	84.70	4	11	5	7	18	5	8
3	6	+3	Singapore	83.05	15	5	12	21	1	7	12
4	3	-1	Germany	82.53	9	4	17	3	28	19	7
5	4	-1	Switzerland	82.34	7	7	8	9	11	17	17
6	7	+1	Japan	81.91	3	6	24	8	34	10	3
7	5	-2	Finland	81.46	8	16	10	13	19	6	4
8	8	0	Denmark	81.28	6	15	11	15	26	2	10
9	11	+2	France	80.75	12	35	14	2	10	21	9
10	10	0	Israel	80.64	1	27	9	5	41	1	19
11	9	-2	U.S.	80.42	10	23	6	1	42	20	2
12	12	0	Austria	79.12	5	8	15	26	12	12	5
13	16	+3	Ireland	77.87	22	1	1	18	20	14	33
14	13	-1	Belgium	77.12	11	22	13	10	37	13	21
15	14	-1	Norway	76.76	19	37	19	11	23	8	14
16	15	-1	Netherlands	75.09	17	26	20	6	47	15	18
17	17	0	U.K.	74.54	20	40	23	14	8	18	15
18	18	0	Australia	74.35	14	46	16	17	17	3	20
19	21	+2	China	73.36	16	19	40	12	4	42	6
20	24	+4	Italy	68.88	25	20	22	20	32	36	23
21	22	+1	Poland	68.74	35	13	37	16	14	34	24

Transforming our world: the 2030 Agenda for Sustainable Development



清華大學

“Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all”



Strengthen the means of implementation and revitalize the global partnership for sustainable development

SDGs No.7: Ensure access to affordable, reliable, sustainable and modern energy for all



- 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
- 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix
- 7.3 By 2030, double the global rate of improvement in energy efficiency
- 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

Intrinsic demand of sustainable development



- High level of **theoretical system** (Science)
- High quality of **intellectual property** (Technology & Engineering)
- High value-added **product and service** (Entrepreneurship & Innovation)
- High speed of **innovation diffusion** (Technology Transfer)
- Better design of **inclusive public policy** (Innovation-oriented policies and governance)

China's Road Towards Innovative and Sustainable Development Country



Three Steps of China Innovation Road
《National Innovation - Driven Development Strategy》 (《国家创新驱动发展战略纲要》)

2020

Become Innovative Country

2030

Become Top 10 Innovation-Oriented Country

2050

Become the world-class science and technology innovation power, Become the major science center and innovation heights

Key Points of China's Energy National Plan (2016-2020)



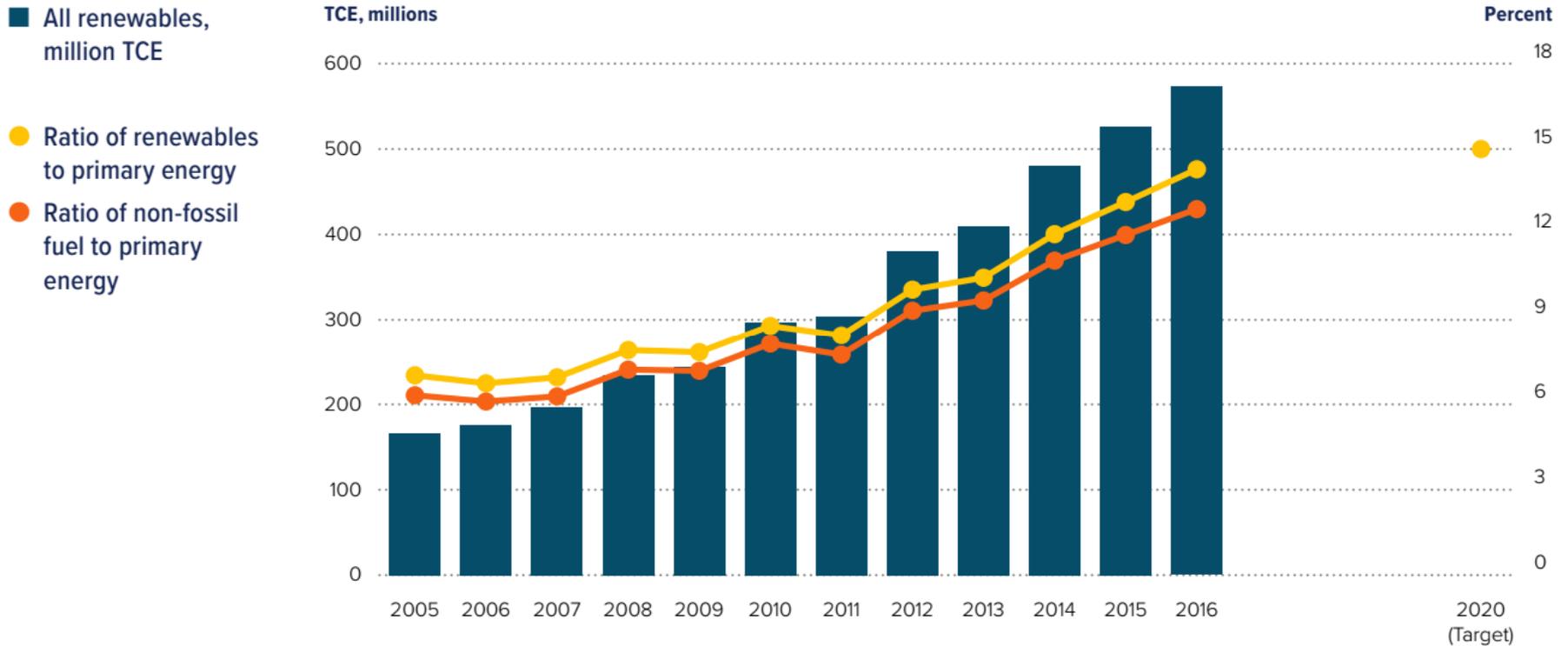
- **Energy security:** Energy self-sufficiency rate reaches 80%.
- **Energy structure:** The proportion of non-fossil energy consumption increased to more than 15% by 2020, (20% by 2030), the proportion of natural gas consumption reached 10%, and the proportion of coal consumption decreased to less than 58%.
- **Energy system efficiency:** Energy consumption per unit of GDP by 2020 should be 15% lower than that in 2015.
- **Environmental protection and low carbon:** Carbon dioxide emissions per unit of GDP are 18% lower than in 2015.

China as the Renewable Energy Powerhouse



- Over the past decade, China has played a significant role in global renewable energy development. In 2008, China ranked 5th worldwide in the amount of wind-generated electric power. In 2011, the country moved up to 2nd place, next only to the U.S., and in 2016, it overtook the U.S. to reach 1st place.
- Solar photovoltaic (PV) generation also increased quickly from 2014 through 2016, when China replaced the U.S. at the top in this metric. By the end of 2016, China boasted the highest installed capacity of RE sources in the world:
 - China came in 1st globally in the hydropower installed capacity for many years in a row;
 - China was on top in total wind power installations and total solar thermal heat usage for five consecutive years;
 - China has been number 1 in PV since 2011 with the exception of 2014, when it fell behind

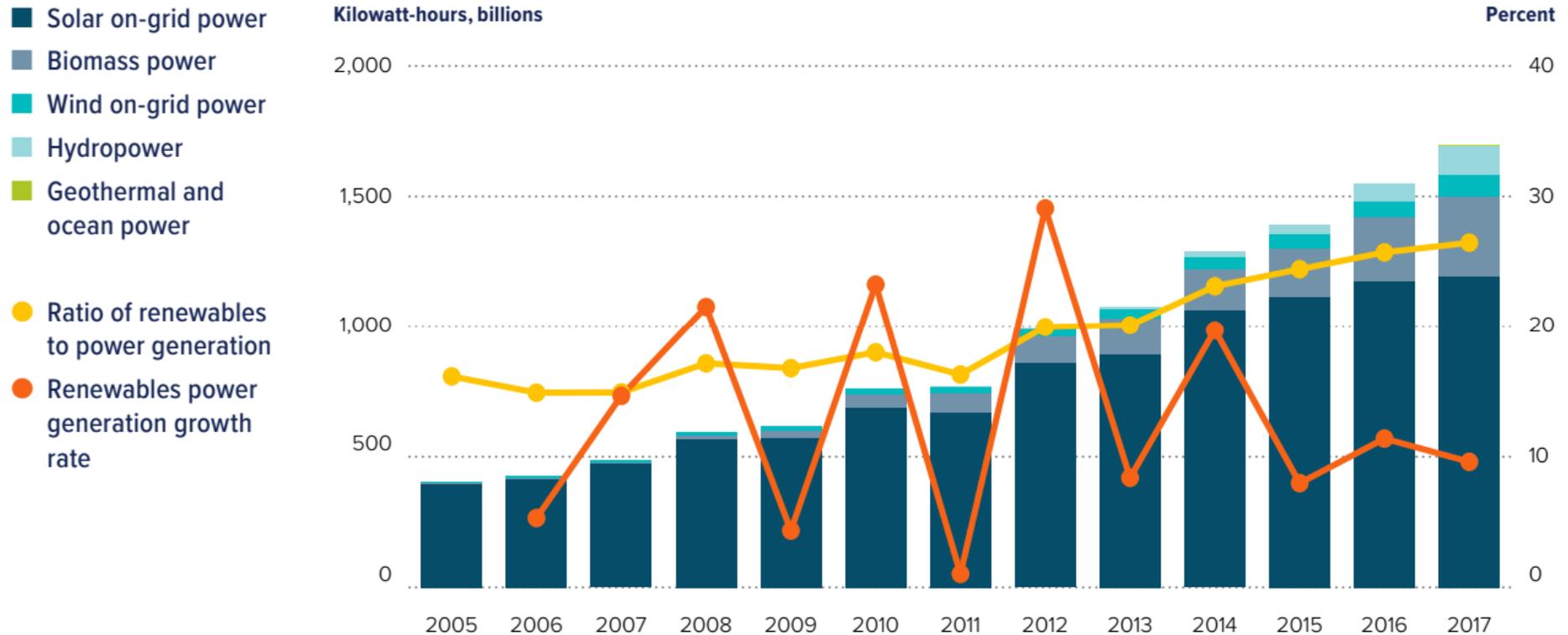
China's renewable energy usage, 2005–16



Source: CNREC, 2017b.

Note: 'Primary energy' is energy that is used directly in its natural form, without any modification. Examples are raw coal, crude oil, natural gas, hydropower, and wind and solar energy, among others. Primary energy is divided into renewable (such as wind and solar) and non-renewable (such as fossil and nuclear) sources. TCE = metric tonnes of coal equivalent.

China's renewable energy electricity generation, 2005–16



Source: CNREC, 2017b.

Note: There are no available data for the growth rate of renewable power generation for 2005.

Comments from Global Innovation Index 2018



- “Closely linked to the national energy transition, RE relies on innovative development to efficiently reduce the consumption of coal.
- Long-lasting policies and measures can safeguard the development of RE technology and industrial innovation, whereas diversified and locally suitable business models along with innovative financial tools will undoubtedly facilitate cost reduction, commercialization, and expansion of its technology.”

Comments from Global Innovation Index 2018



- “As a top consumer and producer of energy, China is experiencing a transition from the traditional approach of coal dominance with its high environmental cost to a low-carbon, environment-friendly system. ”
- “The Chinese government has developed a comprehensive package of strategic policies and measures to promote an overall transition of the energy system towards sustainability and low carbonization, with the goal of raising the share of nonfossil energy to 15% of primary energy consumption by 2020, and to 20% by 2030.”

Key Drivers for China's Renewable Energy Achievement



- Policy innovations:
 - Promulgated the Renewable Energy Law, which established the legal basis for the country's RE development, especially the terms of the 'full purchase' and 'feed-in tariff' provisions.
 - West Electricity Supplying East program
 - The Ministry of Science and Technology has long prioritized RE technology as one of the areas to receive national innovation funding
 - Programms that aim to promote the industrialization of these technologies, such as the Solar Leading Runner and the Solar PV Alleviating Poverty programs
- Technological innovations:
 - Engaged in exchanges with Denmark and Germany over wind turbine technology and human capacity building.
 - Prioritized the development of RE technologies with a promising market and rapidly advancing and significant industrial scale-up expansion;
 - Values intellectual property rights protection to encourage RE innovation.
 - From 2007 to 2012, there were 1,203 patent applications worldwide related to the yaw system. China had the biggest share, with 318 applications.
- Business and financial model innovations:
 - Total investment in China's RE for 2016 amounted to US\$78.3 billion. Not counting large hydropower, the Chinese market share was 32% of total RE investment worldwide;
 - financing for small and distributed PV projects reached US\$3.5 billion, 13 an increase of 32% over 2015.
 - China has adopted a two-pronged approach: one prong is securing quick growth by building major PV stations, and the other prong is supporting the development of distributed PV stations with innovative financing models.

Business Model Innovation: Public Private Partnership



GOVERNMENT



COMPANIES

UNIVERSITIES /
INSTITUTES



众泰汽车
ZOTYE AUTO



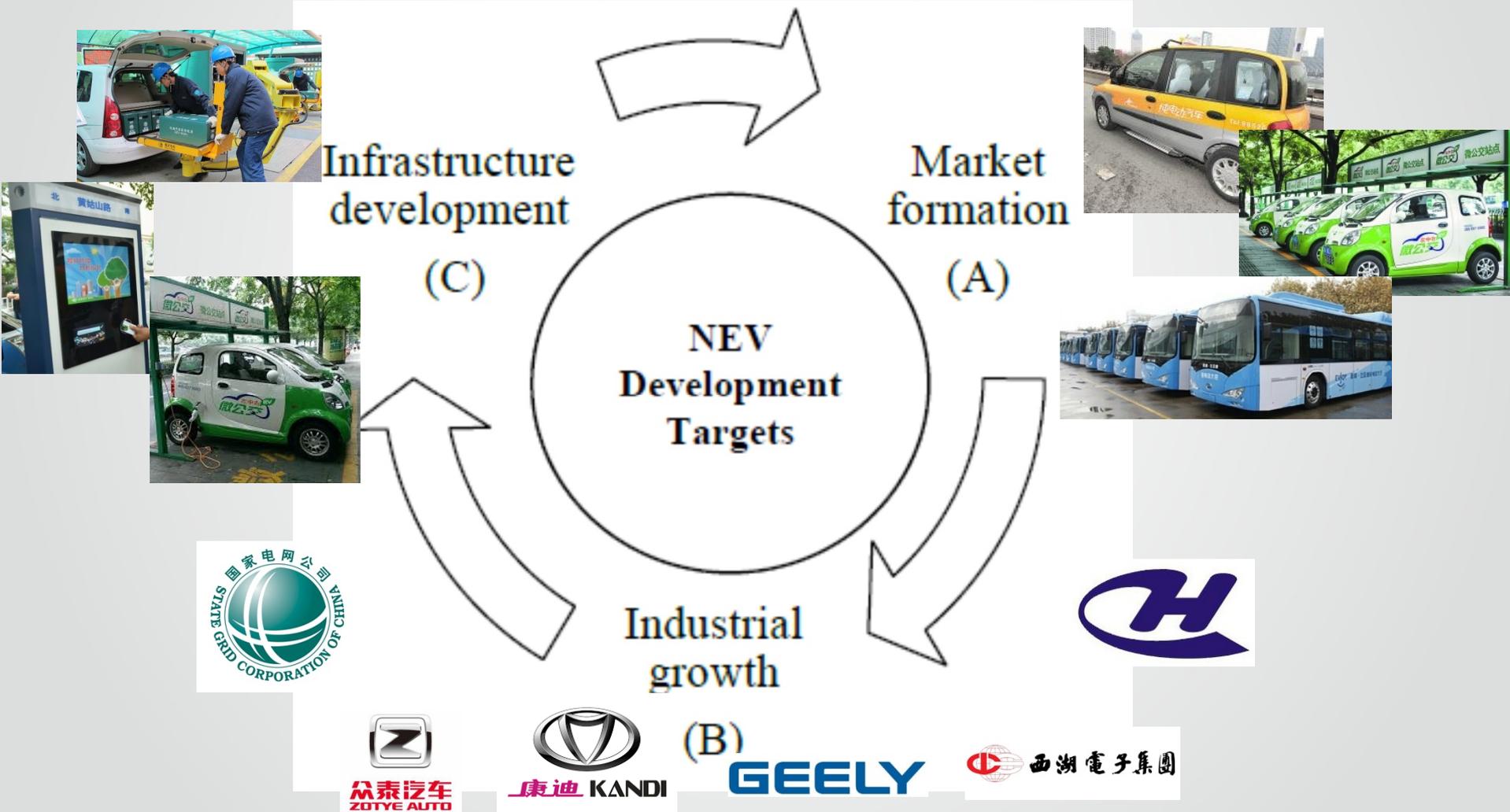
康迪 KANDI



GEELY



PPP And Business Model Innovation To Achieve The Target



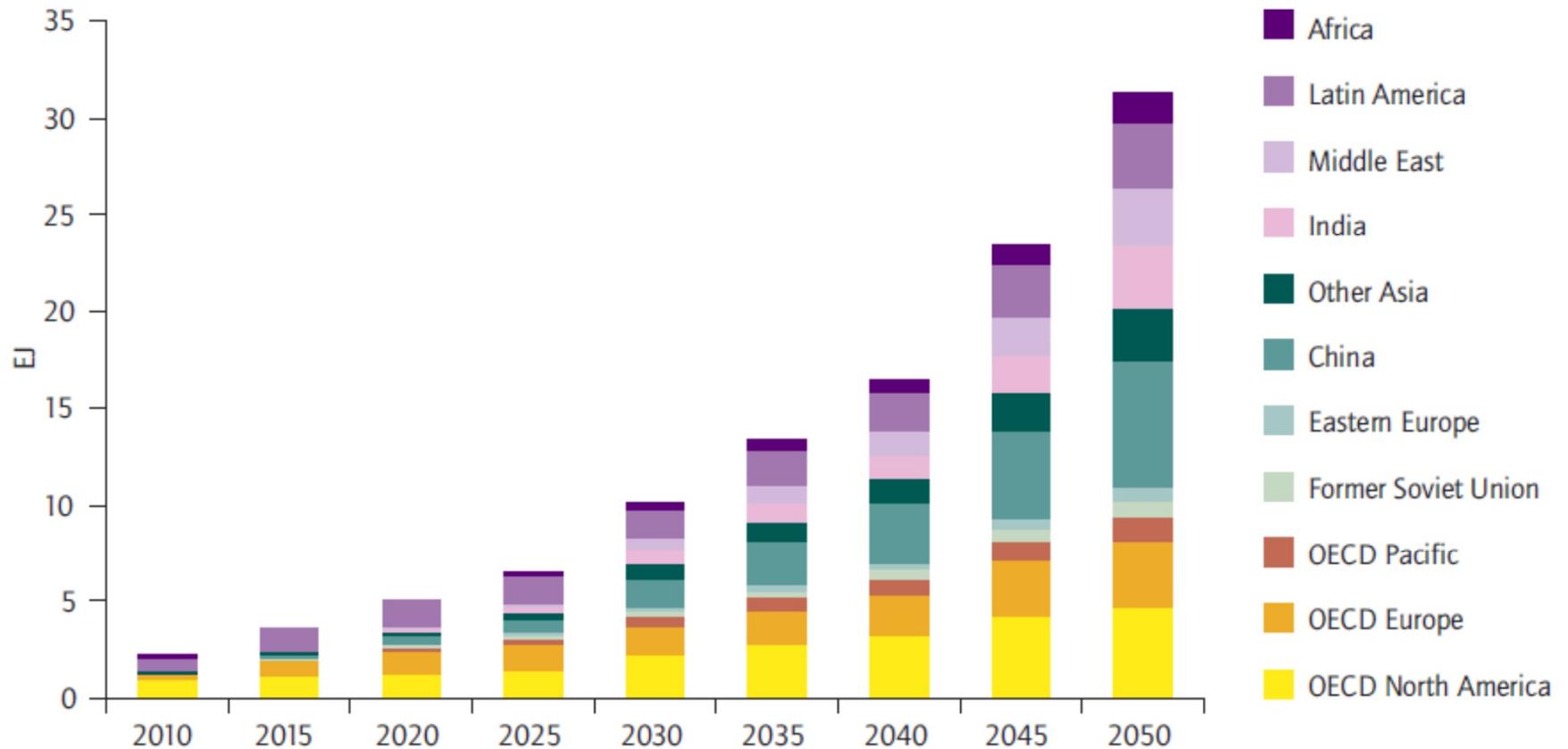


Case1: China's New Energy Vehicle and Innovation Policy

Biofuels for Transport



Figure 8: Biofuel demand by region 2010-50



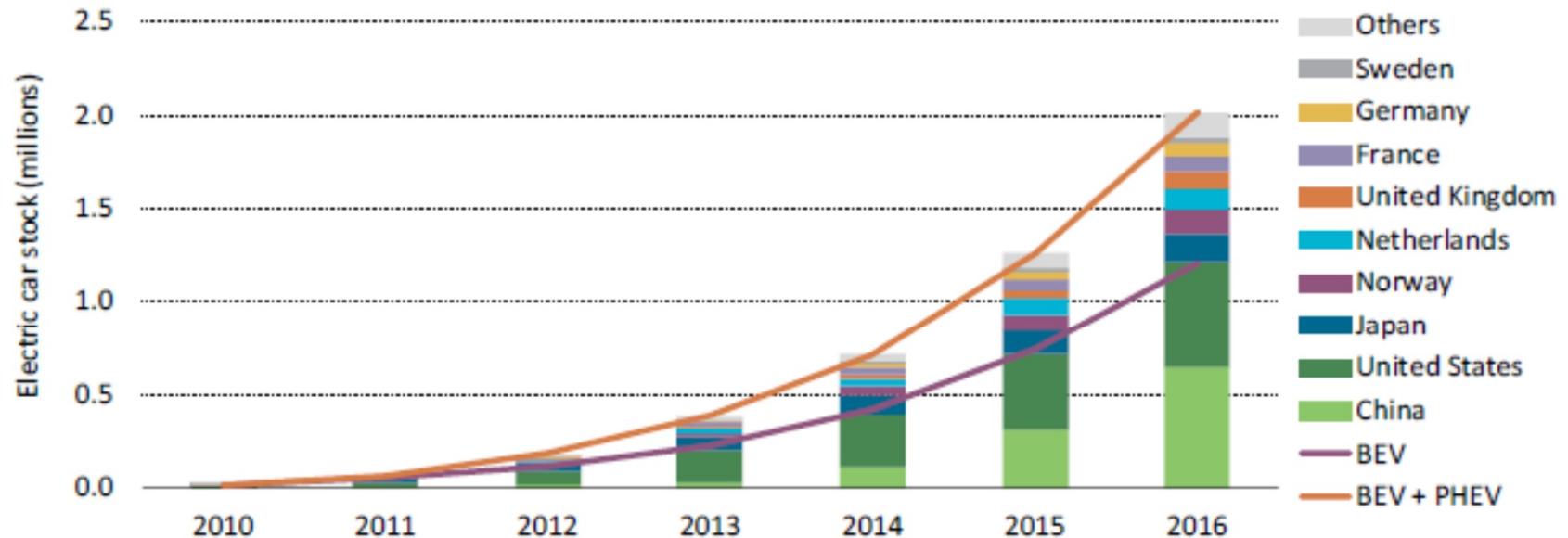
Note: FSU= Former Soviet Union.

Source: IEA, 2010c.

Global EV Market



Figure 1 • Evolution of the global electric car stock, 2010-16



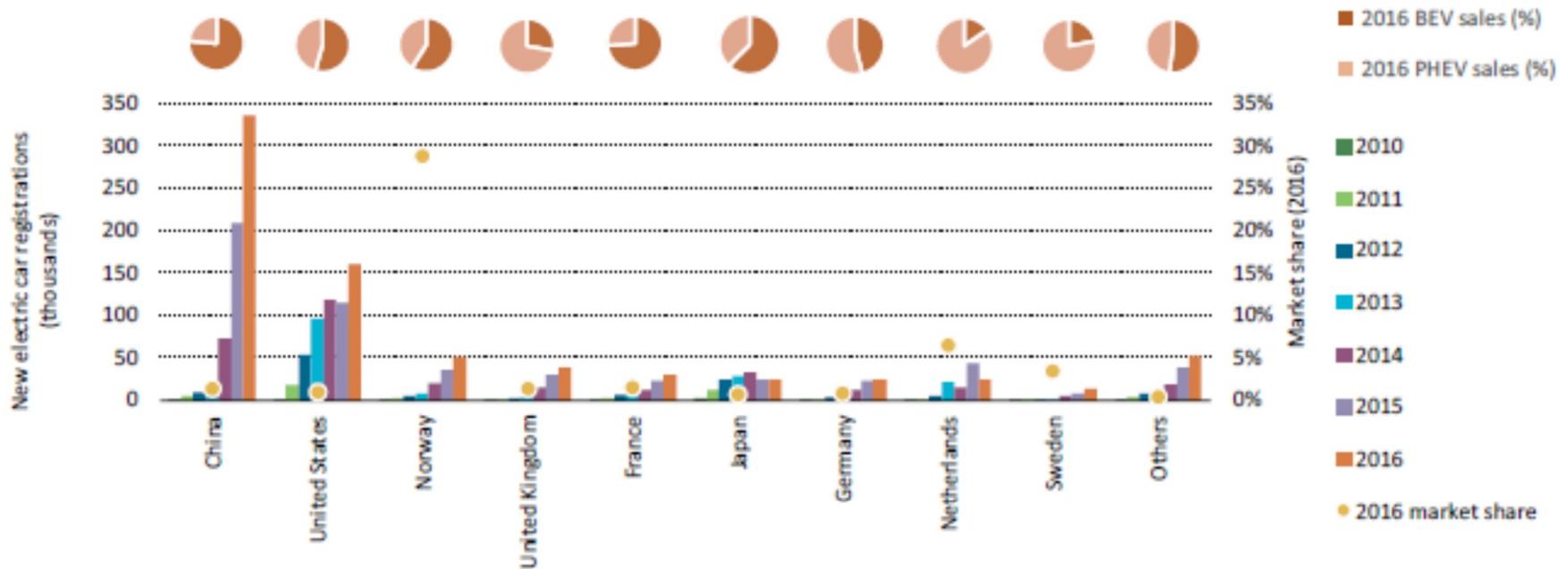
Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.

Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a), IHS Polk (2016), MarkLines (2017), ACEA (2017a, 2017b) and EEA (2017).



China is the leading market of EVs

Figure 5 • Electric car sales, market share, and BEV and PHEV sales shares in selected countries, 2010-16



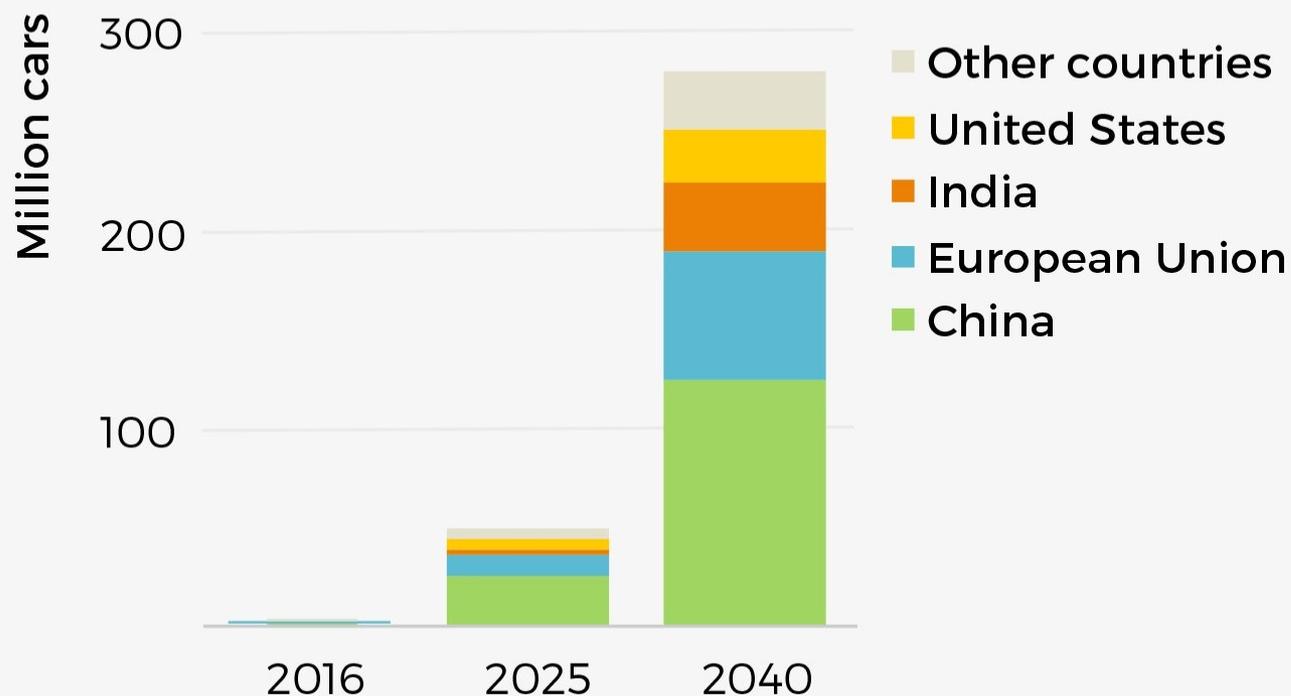
Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a), IHS Polk (2016), MarkLines (2017), ACEA (2017a, 2017b) and EEA (2017).

Key point: The two main electric car markets are China and the United States. Six countries reached EV market shares of more than 1% in 2016: Norway, the Netherlands, Sweden, France, the United Kingdom and China.



Electric car fleet, 2016-2040

World Energy Outlook 2017



China's Policy Towards NEV Innovation



2001

- National High-Technology Research and Development Program (10th Five-year Plan)
- Aiming to kick off 10 cities

2007

- New Energy vehicle Production Entrance Guideline
- Defining and classifying NEV and emphasizing the production permission from the NDRC

2009

- Thousand Vehicles Program
- Aiming to promote NEV at 25 cities

2010

- Notice on the Expansion of Energy-Saving and New Energy Vehicles Demonstration

2011

- Official Letter on Strengthening Safety Management in the Demonstration of New Energy

2012

- Energy Conservation and New Energy Vehicle Industry Development Plan
- The 12th Five-Year Plan

2013

- Notice on the Continuation of Popularization and Application of New Energy Vehicles

2014

- Notice on the Exemption of New Energy Vehicle Purchase Tax
- Guidance on Speeding Up the Popularization and Application of New Energy Vehicles

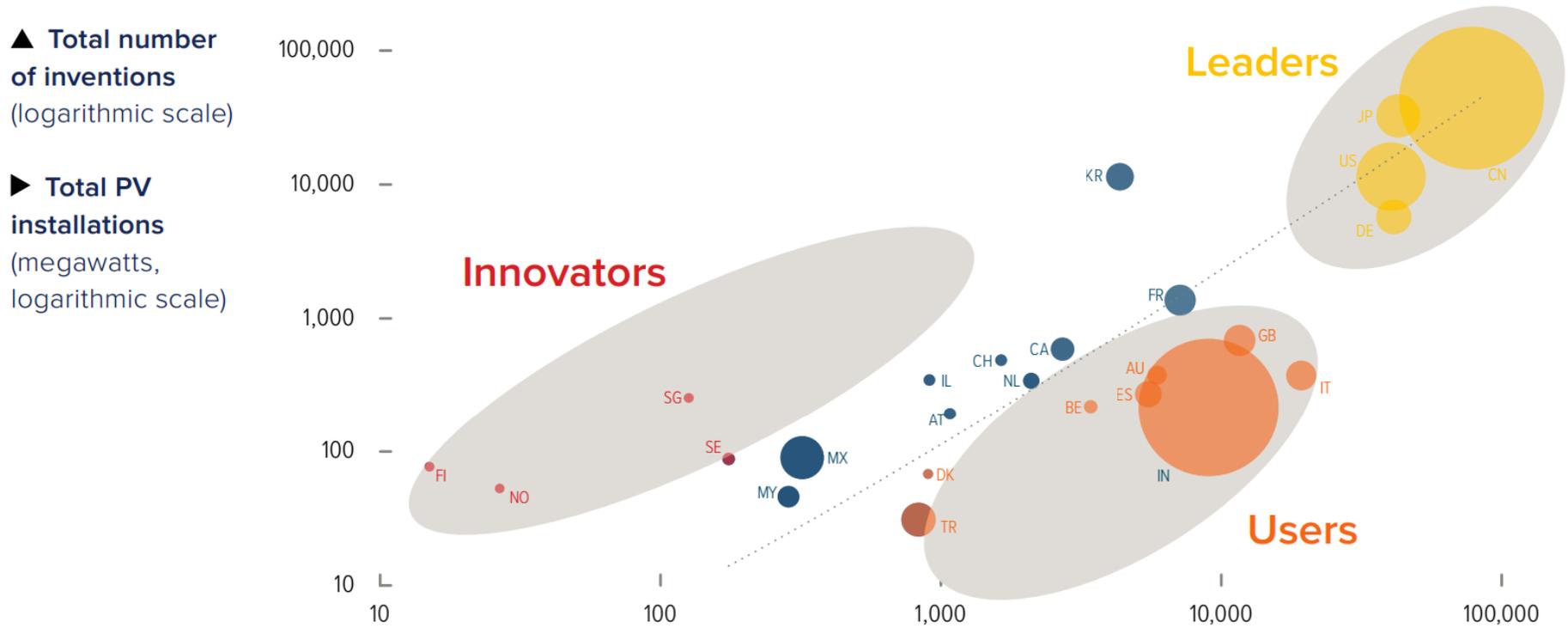
2015

- Notice of Reward Policies
- The 13th Five-Year Plan
- Made in China 2025



Case2: China's PV, Solar Energy Innovation & Policy

Photovoltaic (PV) technologies: Leaders, innovators, and users



Sources: UN DESA, 2017; EMA Singapore, 2016; IEA, 2016a.

Note: Bubbles are sized by population. ‘Leaders’ have the most PV technologies and greatest number of PV system installations; ‘Innovators’ have higher than average PV inventions compared to system installations (above the curve); and ‘Users’ have fewer than average PV inventions compared to system installations (below the curve). The trend line is a polynomial of degree 2 with intercept ($R^2 = 0.8183$). ISO-2 country codes: AT = Austria; AU = Australia; BE = Belgium; CA = Canada; CH = Switzerland; CN = China; DE = Germany; DK = Denmark; ES = Spain; FI = Finland; FR = France; GB = United Kingdom; IL = Israel; IN = India; IT = Italy; JP = Japan; KR = Republic of Korea; MX = Mexico; MY = Malaysia; NL = Netherlands; NO = Norway; SE = Sweden; SG = Singapore; TR = Turkey; US = United States of America.



China's rapid Innovation of PV and Solar Energy

- China's rapid expansion of PV facilities has attracted worldwide attention. It now leads the pack with close to 60,000 PV-related inventions and is the world's largest producer of solar energy, installing more than 34 gigawatts (GW) of solar capacity in 2016—more than double the figure for the United States of America (U.S.) and nearly half of the total added capacity worldwide that year.
- A government report even suggested that, by 2050, renewables could supply 86% of the country's energy needs, with solar providing about a third of this supply.

China's Policy Towards PV Innovation



- Several pro-PV government policies, along with surging global demand, have contributed to this trend. In December 2016, the National Development and Reform Commission—the country's national economic planner—announced a planned investment of US\$158 billion as part of the Chinese government's bid to boost PV capacity fivefold.
- These key fiscal policy measures have encouraged Chinese firms to forge more partnerships with research institutes and pay for technology licenses, which further spurred PV innovation in the country



Case3: Promote Develop Nuclear Energy and Application, Take China National Nuclear Corporation(CNNC) as an Example

Energy Innovation by CNNC



- CNNC's breakthrough innovation focus on three main technologies: software, fuel and key Equipment
- For example, devoted to continuous R&D for more than 30 years, CNNC has succeeded in developing its own G3 GW-output reactor of the export type — Hualong-1 — which is hopefully to be completed and commissioned by 2020. The reactor will be the first in the world to be committed to operation as the final step of a design schedule.



清华大学
Tsinghua University

Case 4: Promote Smart and Energy Internet, Take China National Petroleum Corporation (CNPC) as an example



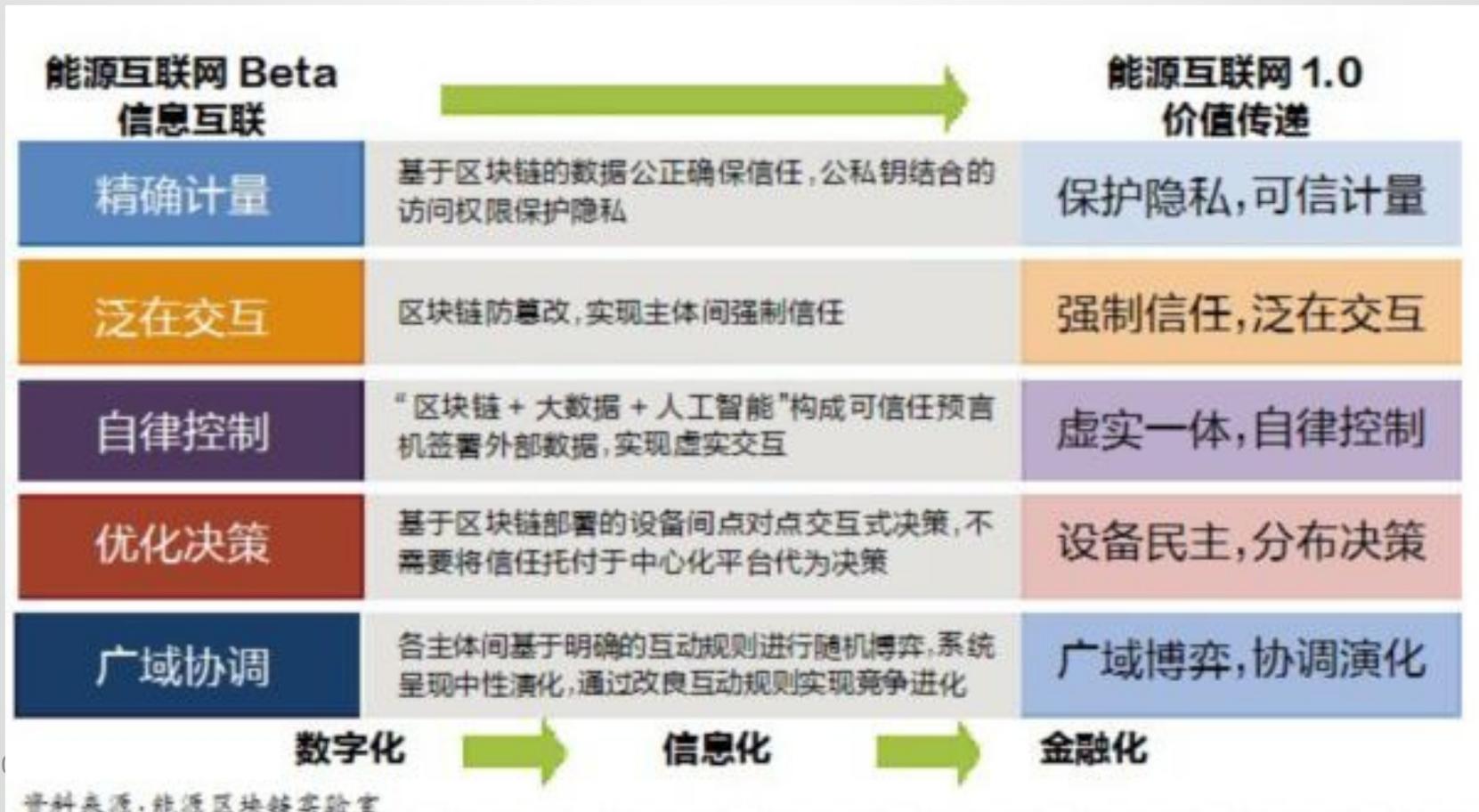
Smart Energy & Energy Internet

- The National Development and Reform Commission issued the *Guiding Opinions on Promoting the Development of "Internet +" Smart Energy*.
- CNPC is the world's 3rd largest oil company based in China and plays a leading role in China's Smart Energy and Energy Internet
- CNPC now has 84 research institutes, 47 key laboratories and test bases with a total number of more than 33,000 researchers.

Energy Internet: from connection to value co-creation



- Applying blockchain, IoT, AI, data science into carbon emission controlling and



Journal of Global transitions

Connecting. Forward Thinking



- ***Global Transitions*** is a freely accessible platform to share actionable knowledge and forward-thinking perspectives on transitions in the broader fields of health, energy and technology.
- **Editor-in-Chief:** Kristie Ebi, Luisa Cabeza, [Jin Chen](#)
- “We believe in a brighter future”.



清华大学
经济管理学院
SCHOOL OF ECONOMICS AND MANAGEMENT
TSINGHUA UNIVERSITY

Thank you