ESMAP 2011 Knowledge Exchange Forum

Renewable Energy Target Study in China

Economic Optimal Quantity vs. Government Targets

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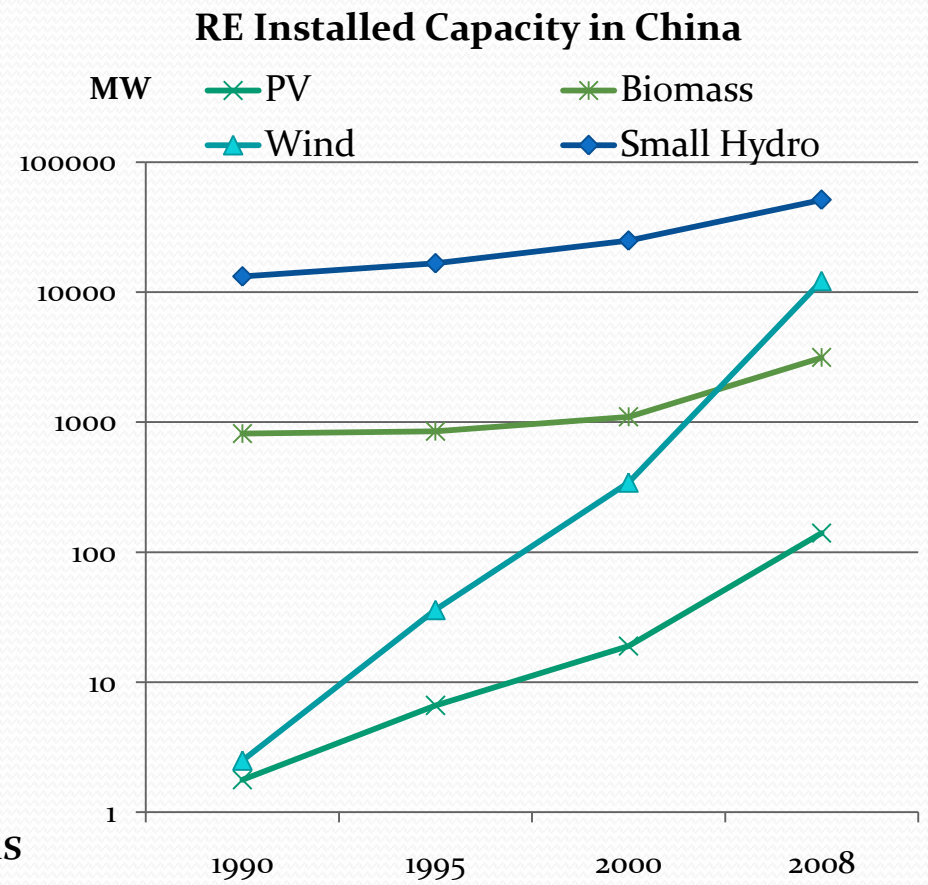
Historical RE Development in China(1990-2008)

- Small Hydropower:
  - Stable growth since 1980s
  - World's leading country in hydropower development
- Wind Power:
  - Stagnation before 2000
  - Fastest growth in the world after 2005 (double each year in 2006, 2007, 2008)
- Biomass Power:
  - Boomed since 2006
- Solar PV:
  - Promoted by government's programs
  - Early development stage



Increasing RE Targets in China

- 9th FYP (1996-2000):
  - Target of wind power in 2000: 1 GW
  - Not met, total capacity of wind power in 2000 was 0.34 GW.
- 2004 Bonne RE Conference:
  - RE share 10% of primary energy needs by 2010
  - 20GW wind power by 2020
  - Increase to 30 GW of wind power by 2020 in 2005 Beijing RE conference
- 2007 RE Medium and Long term Plan:
  - RE share 15% of primary energy needs by 2020
  - 2020 targets: wind power 30 GW, biomass 30 GW, Solar 1.8 GW, Small hydropower 75 GW
- Envisaged RE Target (not announced yet):
  - Wind power 150 GW by 2020
  - Solar PV 20 GW by 2020

Objectives of the Study

- Are the ambitious RE Targets are economically and environmentally justified
- Are the current policies consistent with the GTs
- Incremental Cost and Who pays for it

The Objectives of this study are to answer above Qs:

- Evaluation of the government RE targets against the optimal solutions
- Review of the current policies

A model was developed in about 2000 when CRESP was prepared – an update study based on the same approach and updated RE database

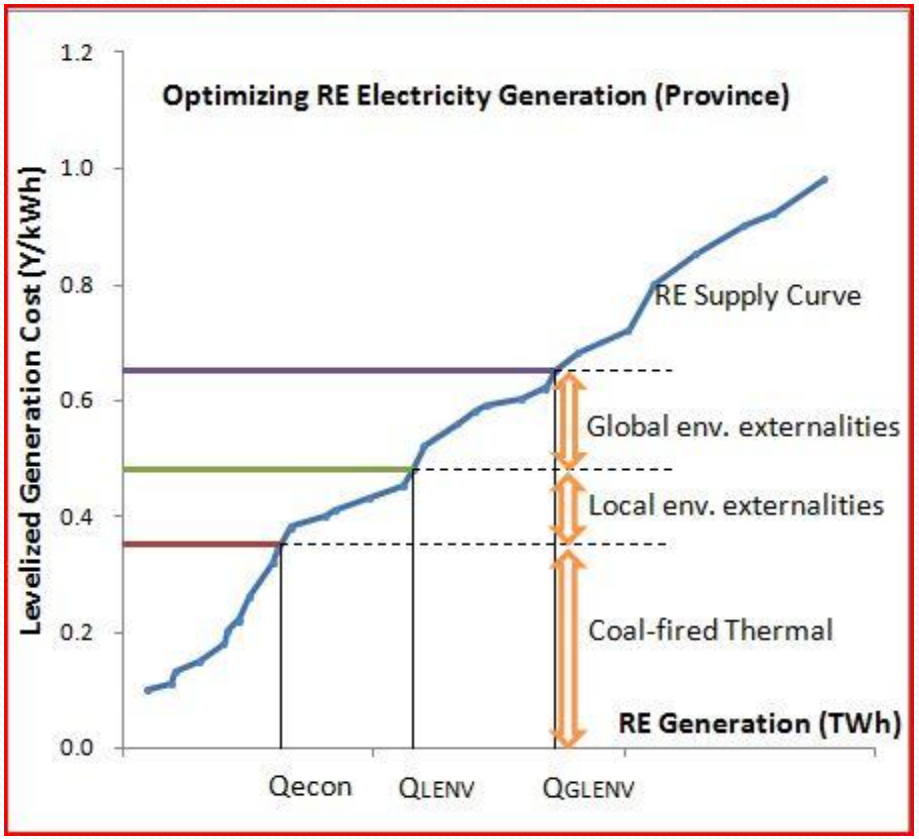
Methodology (1)

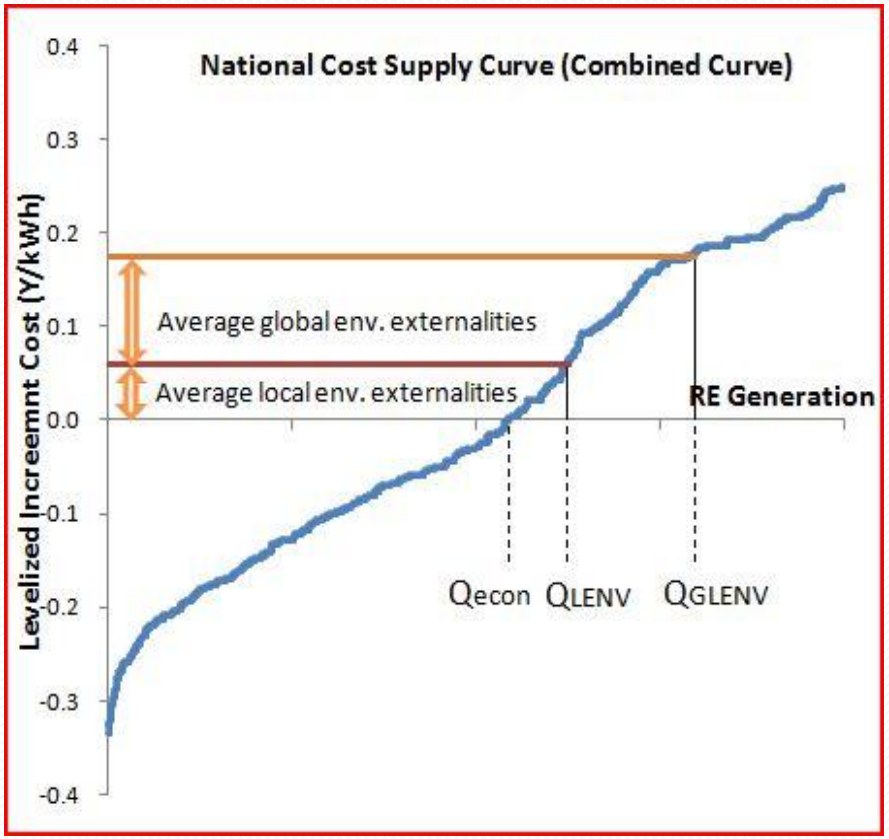
- To determine the optimum share of RE in the total electricity generation considering the economic and environmental assumptions (economic analysis)
  - Build cost supply curve of RE projects
  - Compare with cost of coal-fired thermal
  - Incorporate the environmental externalities (local + global)
- How to apply the method in China:
  - Province by province analysis (huge differences among provinces)
  - Capacity penalty of RE (wind, PV)
  - Combined into the national supply curve based on incremental cost
  - Policy analysis: feed-in tariffs, MMS
  - Impact to different stockholders: winners & losers

Methodology (2)

Provincial Curve
(Levelized Cost)

National Curve
(Incremental Cost)





Major Assumptions

- RE type: grid-connected
  - wind power, small hydro, biomass, and solar PV
- Alternative option: coal-fired thermal (China)
- Social discount rate: 8% (NDRC)
- Technical & Economic Indices
  - capital cost, fuel price, efficiency, capacity factor, …
- Externality – lower/upper limits (uncertainty)

- RE database – Key !!!

Major Assumptions – RE Database

- RE database was established by ERI:
  - Existing, under-construction, and planned RE projects – both national and provincial
- About 1900 RE projects in 31 provinces

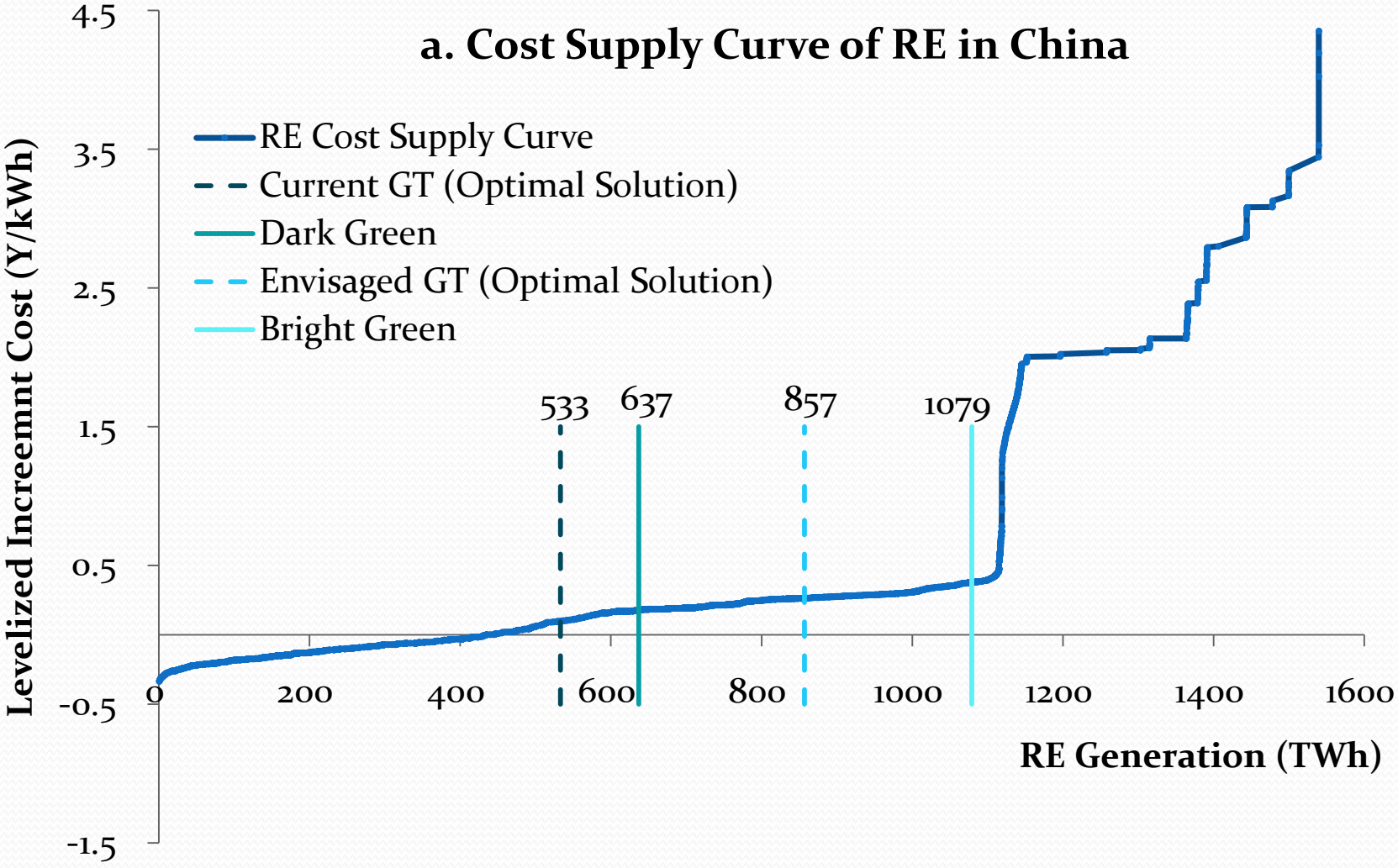
RE technology	RE resources (MW)	Investment (Y/kW)	Fuel cost (Y/ton)	Capacity factor (%)
Wind	173,393	8,700–10,800	—	21–37
Small hydropower	128,045	3,548–9,965	—	13–50
Hydropower rehabilitation	5,243	Avg. 2,870	—	13–50
Biomass	25,364	9,500	260–350	80
PV	22,670	24,000	—	10–25
Total	**354,715**	—	—	—

Note: The RE potential in the table is based on identified or extrapolated grid connected electricity projects, and does not reflect the full RE potential in China.

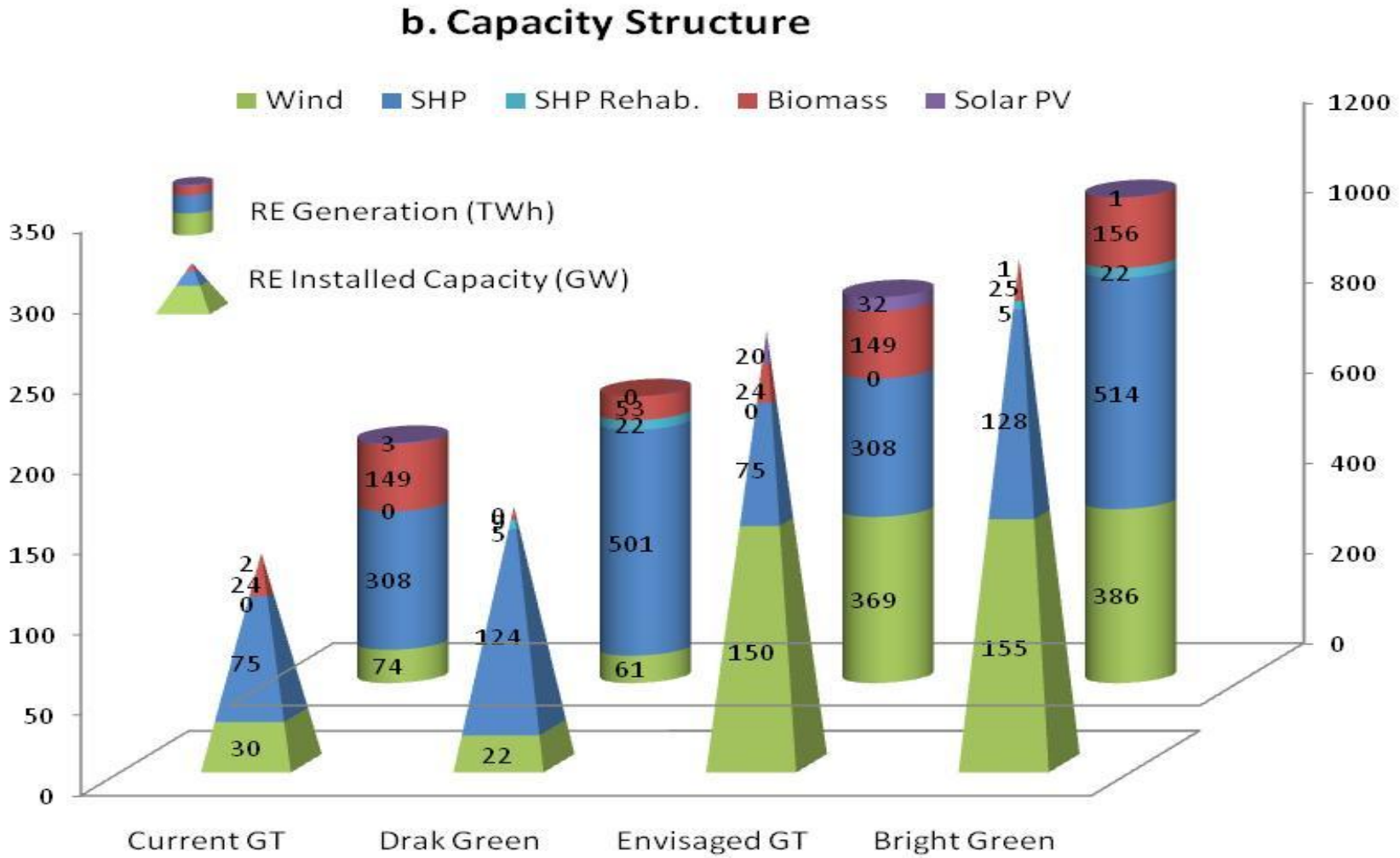
Analytical Framework

- Four RE development Scenarios:
  - Government Targets – Current, Envisaged (2)
  - Optimal Solutions (2)
    - To incorporate the high and Low limit of environmental externalities
- Analysis of Current RE Policies
  - Feed-in Tariff: wind power, biomass, solar PV
  - MMS: with trade vs. without trade
  - Impact on electricity tariff (cost of generation)

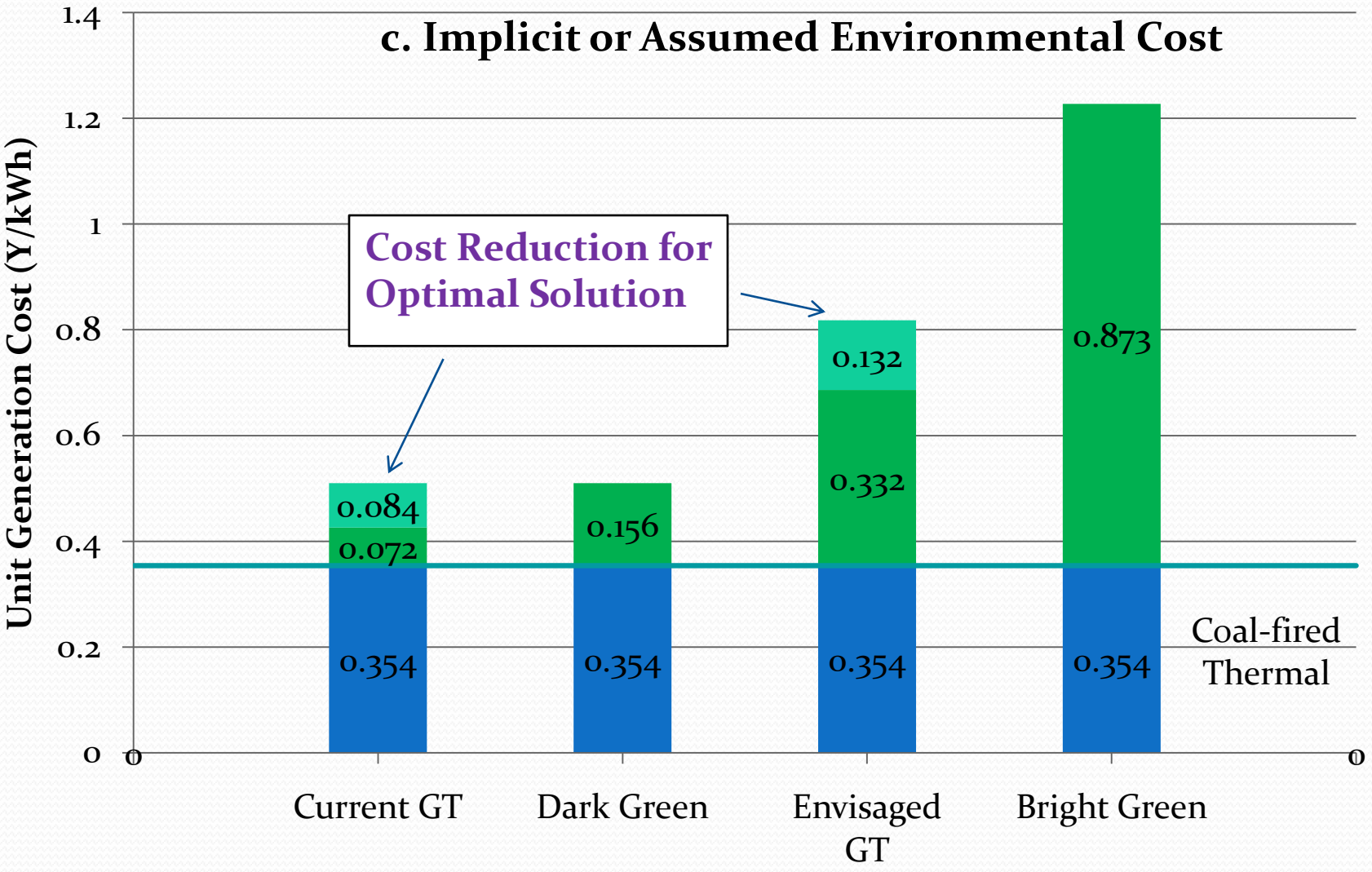
Major Findings (1)



Major Findings (2)



Major Findings (3)



Whether the 15% target is achievable?

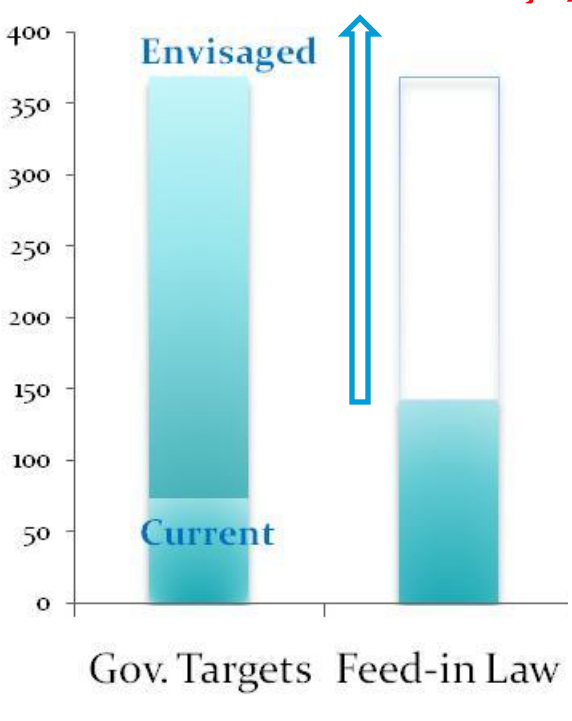
Scenario		Current GT 2020	Envisaged GT 2020	Dark Green 2020	Bright Green 2020
RE Generation	GWh	532914	856900	636849	1079050
Large Hydro (1)	GWh	922500	922500	922500	922500
Other Biomass Generation (2)	GWh	37358	37358	37358	37358
Total RE Supply from electricity	mtce	477.7	581.4	510.9	652.5
Other RE Supply (3)	mtce	137.7	137.7	137.7	137.7
Total RE Energy Supply	mtce	615.4	719.1	648.7	790.2
RE Share (%)	%	12.9%	15.1%	13.6%	16.6%
Nuclear Power	GW	40	70	70	70
Non-Fossil Fuel Share (%)	%	14.8%	18.4%	16.9%	19.8%

Assumptions:

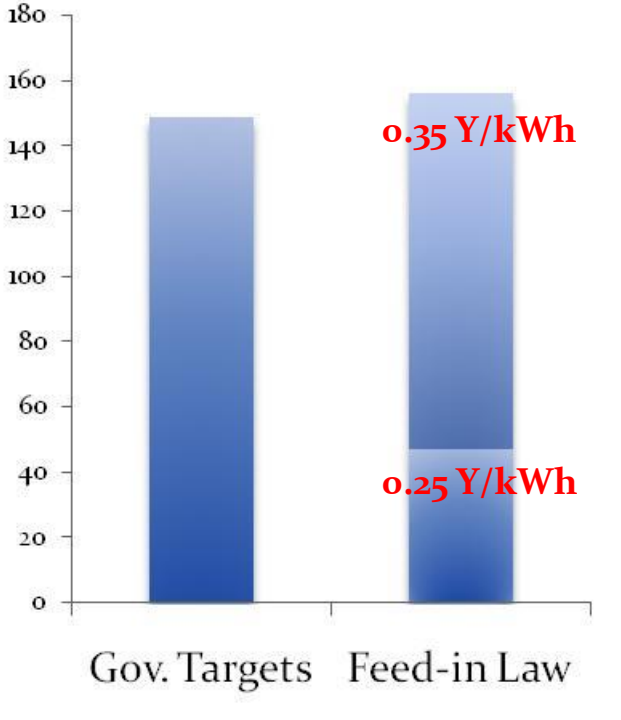
- Energy demand in 2020: 4,772 million tce (China's Low Carbon Development Pathways by 2050, ERI 2009)
- Other REs are assumed to follow 2007 RE plan.

Impact of Feed-in Tariff

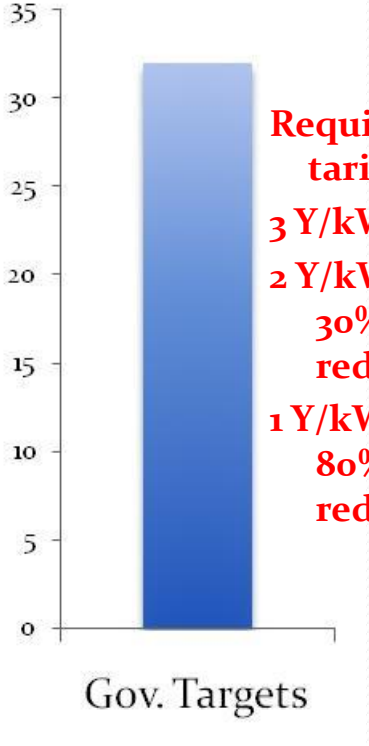
To be met by:
- Increasing tariff, or
- Cost reduction by 17%



Wind Power



Biomass Power



Required tariff:
3 Y/kWh, or
2 Y/kWh @ 30% cost reduction
1 Y/kWh @ 80% cost reduction

Solar PV

Impact of Trade in Mandatory Market Share

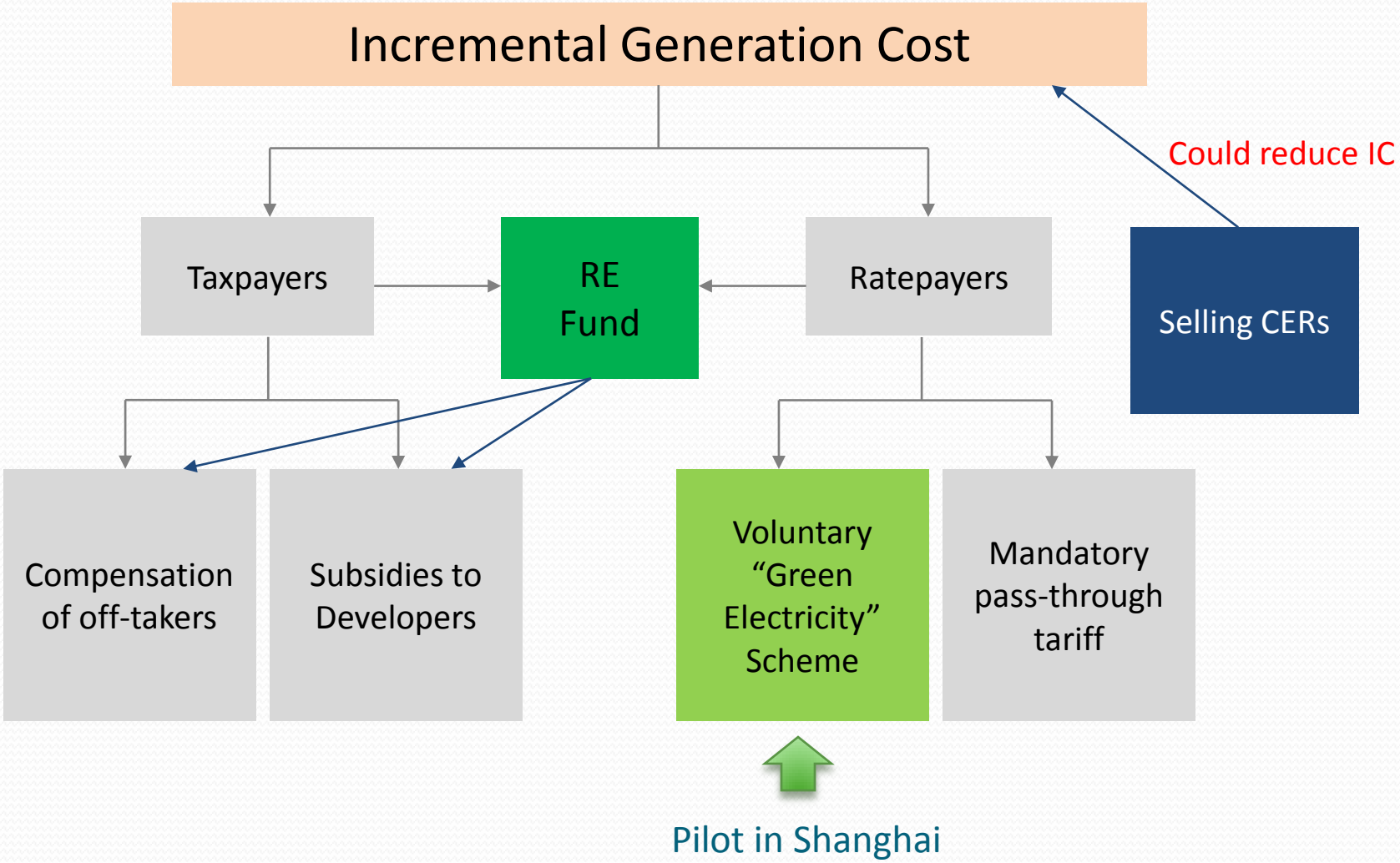
- Two options in meeting the same national Mandatory RE target of EGT - with trade vs. without trade
- With Trade Option:
  - RE transaction – 360 TWh (42% of EGT)
- Without Trade Option:
  - Sizable number of provinces can't meet its share with their own resources identified to date
- Cost comparison:
  - Huge Cost saving: about 56-72%

Impact on Electricity Generation Cost (2020, fen/kWh)

Scenario	Dark Green	Bright Green	Current GT	CGT Optimal	Envisaged GT	EGT Optimal
Wind	0.18	1.79	0.19	0.13	1.59	0.60
Small hydro	-0.82	-0.77	-0.82	-0.82	-0.76	-0.81
Biomass	0.23	0.65	0.58	0.02	0.61	0.60
Solar PV	0.00	0.03	0.07	0.00	1.01	0.00
Total	-0.41	1.70	**0.02**	-0.67	**2.45**	0.39

- Small hydropower development – reduction of 0.8 fen/kWh
- Wind and biomass contribute significantly to the increase of the total generation cost
- PV contribution is negligible in most cases because of low penetration
- For Reference, average electricity tariffs in the regional grids – 20.1 ~ 42.4 fen/kWh (2009, VAT excluded)
- Current surcharge of 0.4 fen/kWh is inadequate to meet EGT → 2.5 fen/kWh is required by 2020

Who pay the Incremental Cost?



Recommendations

- The government targets could be achieved in a more effective manner by:
  - Developing hydropower faster
  - Improving rapidly the performance of wind power
  - Promoting trade among provinces when quota is applied
  - Developing green electricity schemes at the provincial or national level

Replication in Other Countries:

- Peer Reviewers:

  "The Policy Note discusses an important issue and its analysis has *relevance to many other countries* that are currently in the process of setting new targets for 2020 and 2030"

- Press Release after the report publication:
  - Widely quoted by both domestic and international news
  - Interview requests
- Many request for reports from both internal and external readers

Replication in Other Countries:

- Ideas on further dissemination – a product?
  - Methodology Report
  - Two Cases studies – a Province in China, Indonesia (geothermal)
  - Manual + Model
  - CD for dissemination
  - Cross support to other countries

? Additional resources to support above work

Thanks!

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For Questions and Discussions.