Renewable Energy Policy Formulation and Implementation in China

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Objective: Summarize the key issues and options in the renewable energy policy debate since 2000.

- The problem was *not* how to get more demonstration projects, bilateral deals, or even how to profit from CDM and carbon finance.

- Rather it was (and remains) how to achieve *large*-scale implementation of grid-connected RE: what combination of market incentives, laws, and institutional/regulatory arrangements would be required to achieve China's potential

From these insights was created the *China Renewable Energy Scale-up Programme [CRESP]*, a collaborative effort of the Government of China, the World Bank and GEF.

The main challenge: Wind

Rural Energy Development Project REDP: GEF/World Bank project started in 2001

PV component has been a great success:

- 34 participating PV companies, market-driven, transparent subsidy mechanism
- setting up specifications, test and quality verification for SHS. 90% of REDP suppliers ISO 9000 certification by end 2004
- significant price reductions (20Wp system now retails for under $200 with radio & speakers)
- 20 manufacturers; by end 2005, reported sales of 359,000, of which 276,000 were verified under REDP; 100,000 confirmed sales in 2005.

However, the wind component fared less well

- The original design included a $100 million loan for wind farm development on four sites (Huitengxile in Inner Mongolia, Zhangbei in Hebei, Pingtan in Fujian and Shanghai) with a total capacity of 190MW.

- Due to difficulties in securing Power purchase agreements, subsequently scaled down to $13 million to include only the 21 MW wind projects in Shanghai.

The ADB wind project suffered a similar fate

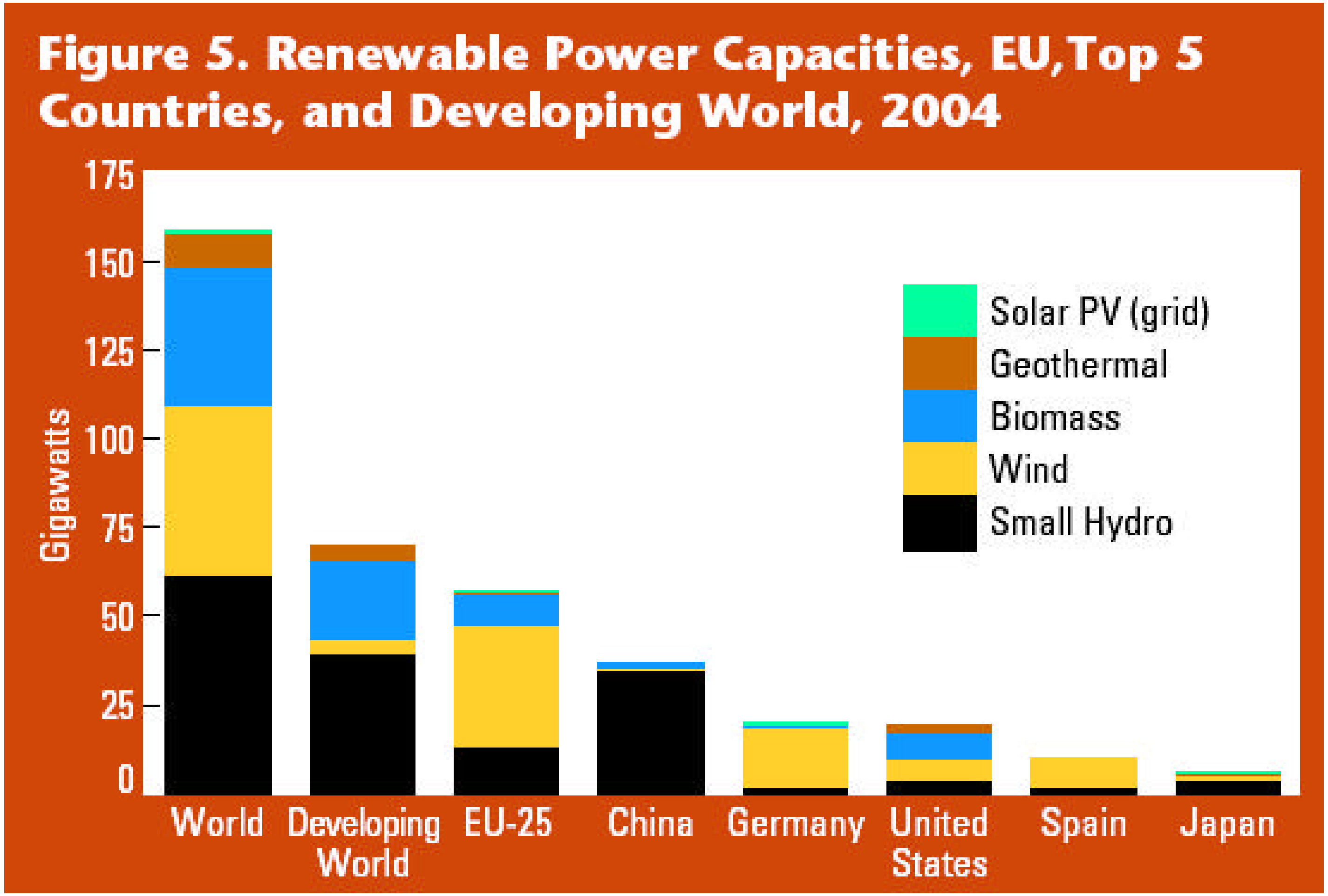
- In 2000, ADB approved a project with three wind farms at Dabancheng (30MW,Xinjiang Autonomous Region); Fujin (24MW, Heilongjiang province), and Xiwazi (24MW, Liaoning province).
- no buyer was found willing to pay actual costs; ADB cancelled the loan in 2003.

Thus the main challenge to CRESP: how do we scale up grid-connected RE projects?

Background

Source: REN-21: Renewables 21: global status report 2005

- China is the world leader in small hydro, 26,000MW
- By end 2005, modest achievement of wind power
- (~1250MW)
- Good results for off-grid, especially PV (100,000+ systems by end 2005).



Initial expectations

Initial expectations of senior policy makers and renewable energy advocates were often conflicting. How the ambitious goals of the 2000 Renewable Energy Development Plan were actually to be achieved was always vague.

Targets for renewable energy generation in the 10th year plan (in MW)

	1998	2000	2010 "basic scheme"	2010 "policy scheme I"	2010 "policy scheme II"
Wind	250	400	3,000	6,000	10,000
small hydro	21,080	23,050	28,930	31,130	33,358
bagasse	400	410	470	500	550
geothermal	40	40	80	80	100

Source: *China New and Renewable Energy 10th 5-year plan and 2010 Development Plan*; SDPC Background Paper, English Translation, November 2000.

1. An increased share of renewable energy is warranted only if it is economic.

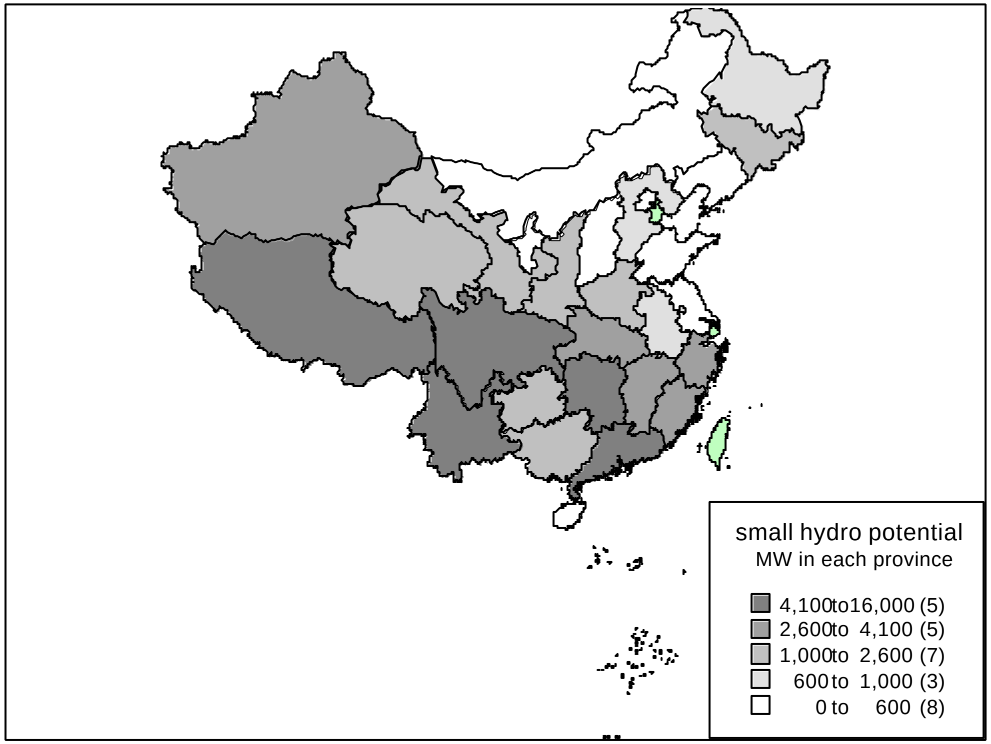
- In 2000-2001 the key concern was China's impending accession to the WTO, and fears that its industrial competitiveness might be compromised if electricity tariffs increased.

- On the other hand, the health damage costs from an ever-greater number of coal-burning projects were recognized as real.

- Agreement was reached relatively quickly that "economic" should include consideration of the avoided *local* externality costs (i.e. damages from PM-10, NOx, SO2), but not global externalities.

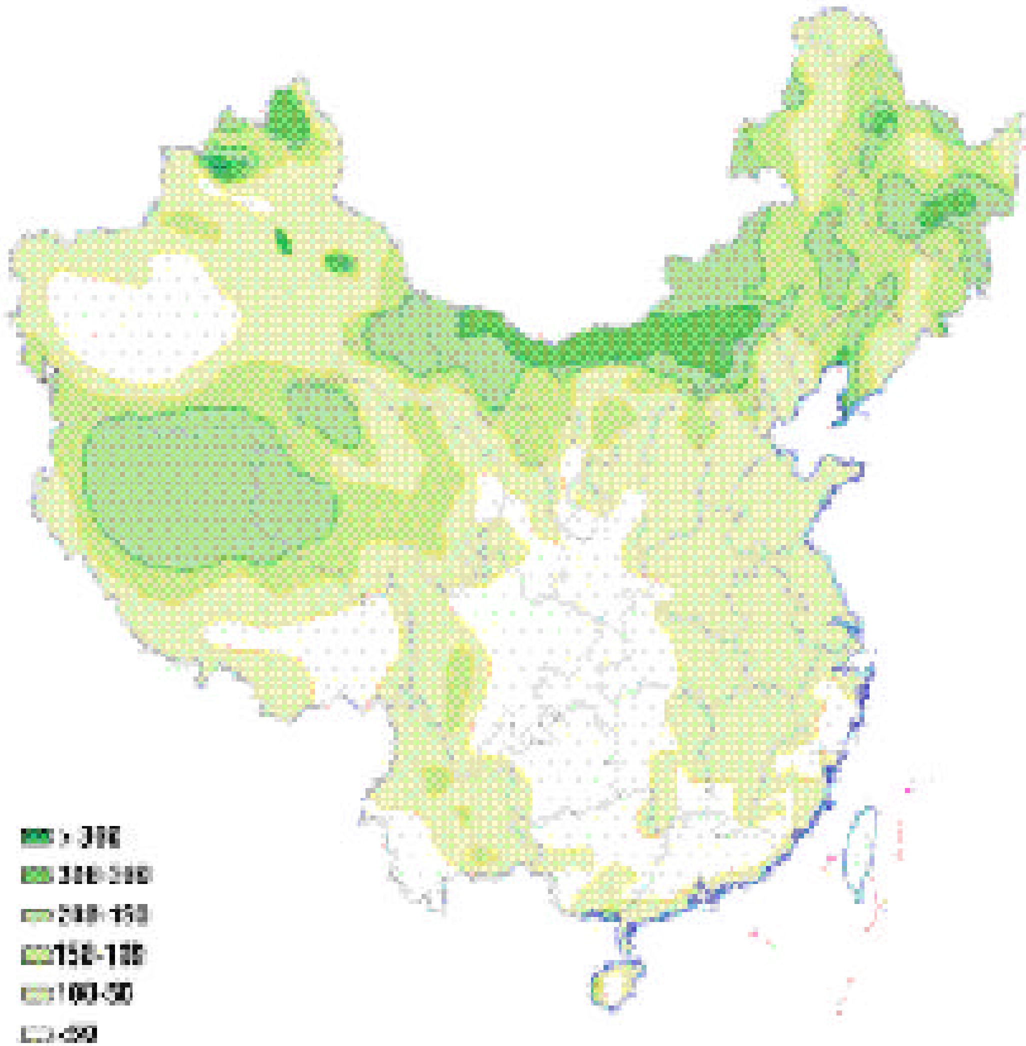
2. Renewable energy resources are mainly in the Western Region, and their development would assist in the Government's goal of western regional economic development.

Small hydro potential by province



(No data for Taiwan and Southern Islands)

Wind resources: best in the western region (includes Inner Mongolia)

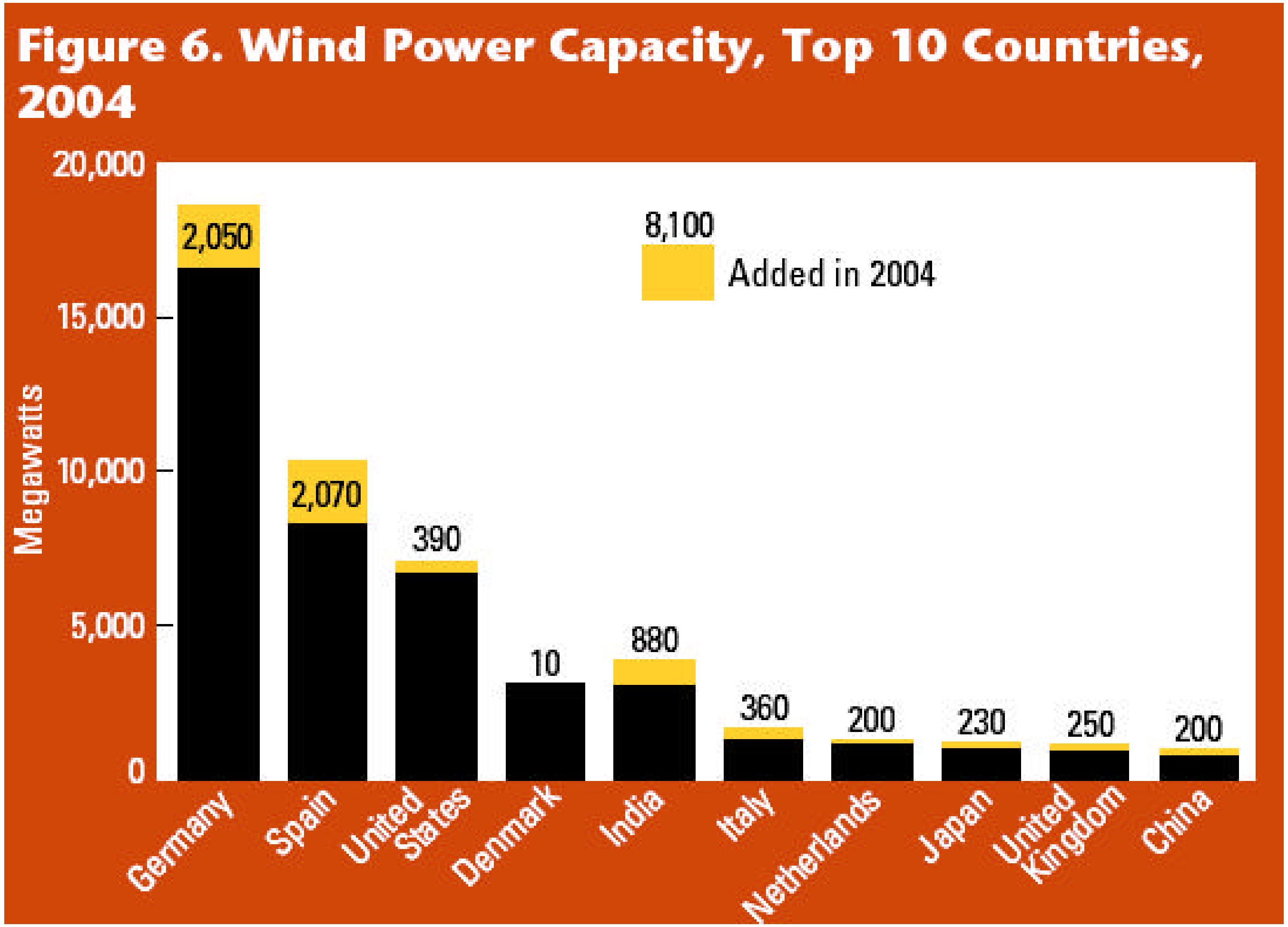


3. With a generous feedlaw price, what's the problem!

Advocates of renewable (and particularly wind) energy, saw the debate in simple terms: follow the German example, and 10GW can be implemented in a few years.

The fallacy of this expectation was dispelled with the cancellation of the ADB loan, and the drastic scaling down of the GEF/World Bank REDP wind component.

And thus progress with wind power has been modest!



Source: REN-21: Renewables 21: Global Status Report 2005

However, in 2005, China reportedly added 498 MW (v. 2430 MW in US, and 1430 MW in Germany, and 11,500 worldwide)

4. Need better data

In 2000, little wind resource data existed, and several major programmes were started

- American National Reneweable Energy Laboratory (NREL)+ Chinese Centre for Renewable Energy Development (CRED) +UNEP wind mapping project
- UNDP+GEF wind measurement and site characterisation project at 10 sites in 8 provinces; this has been expanded by NDRC to more than 30 sites nationwide.

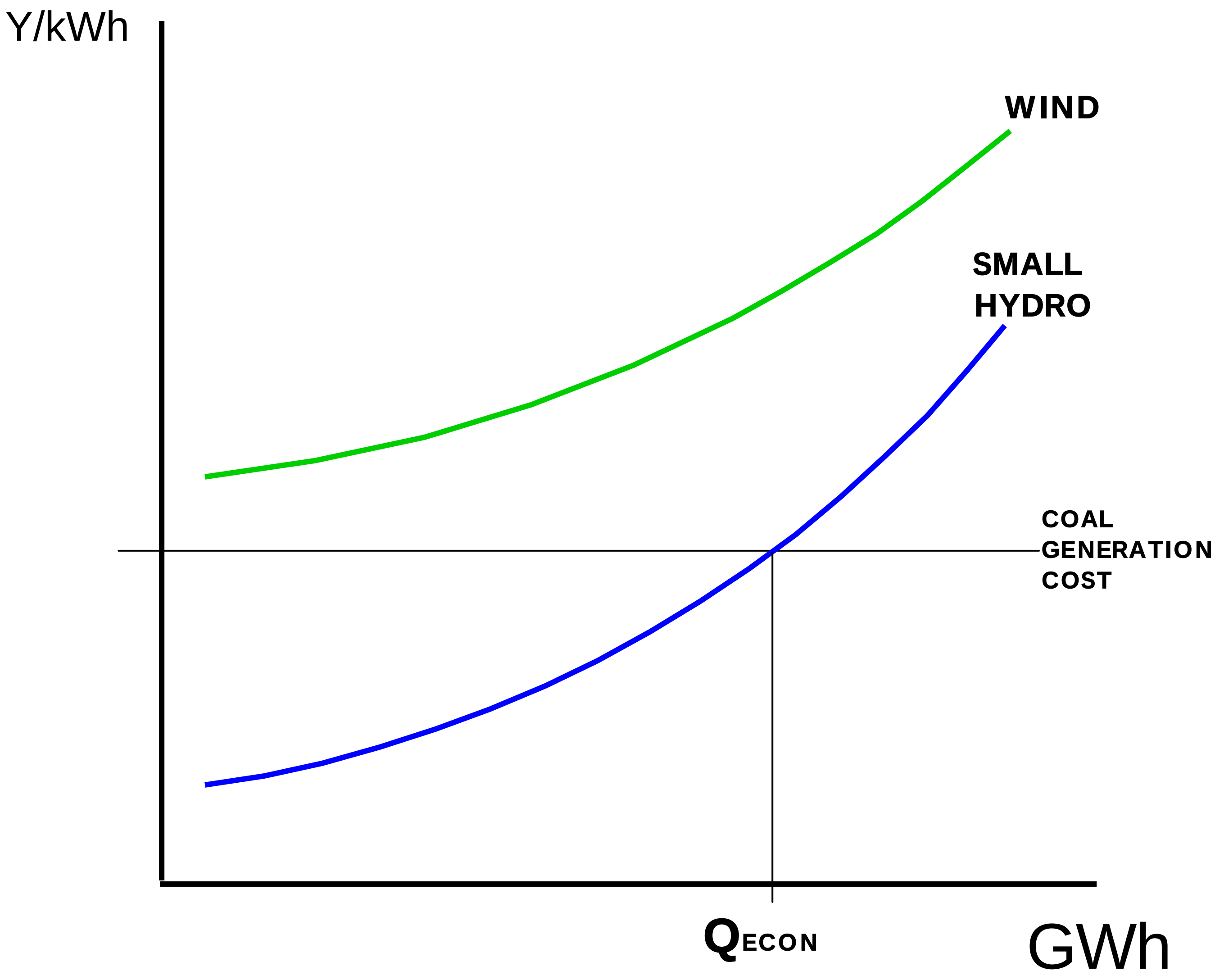
The analytical design: the questions

- How much renewable energy generation is justified with and without consideration of externalities?
- Given such a target, how is it best achieved? There are many possible approaches that have been tried elsewhere: but what would be best for China, and why?
- How do the various policy options perform on criteria other than economic efficiency, such as western region economic development, employment, or energy supply diversification? What criteria should be applied, and how is performance on each of these criteria to be quantified?

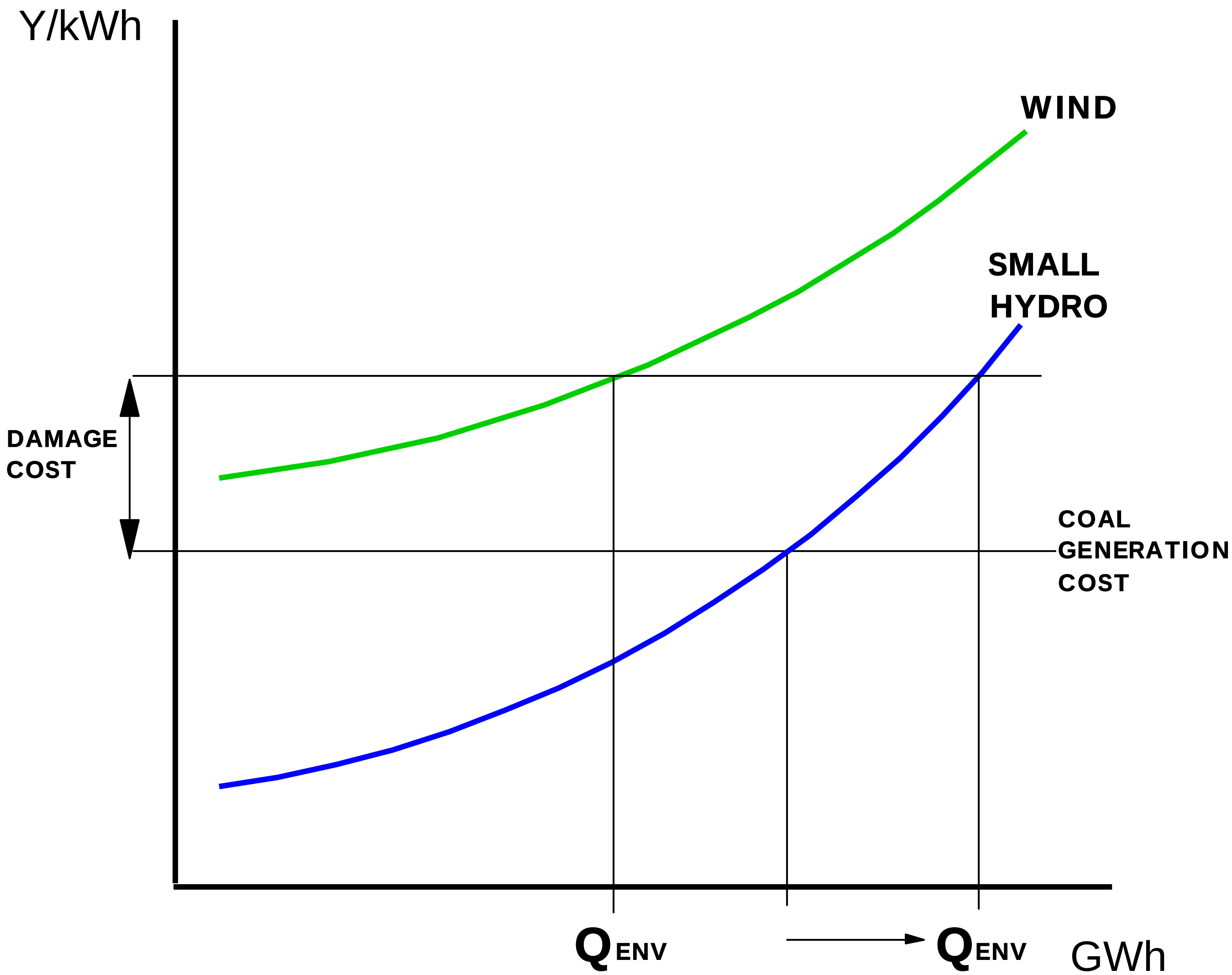
The economically optimal quantity of renewable energy?

Basic approach: derive the renewable energy supply curve, based on economic costs

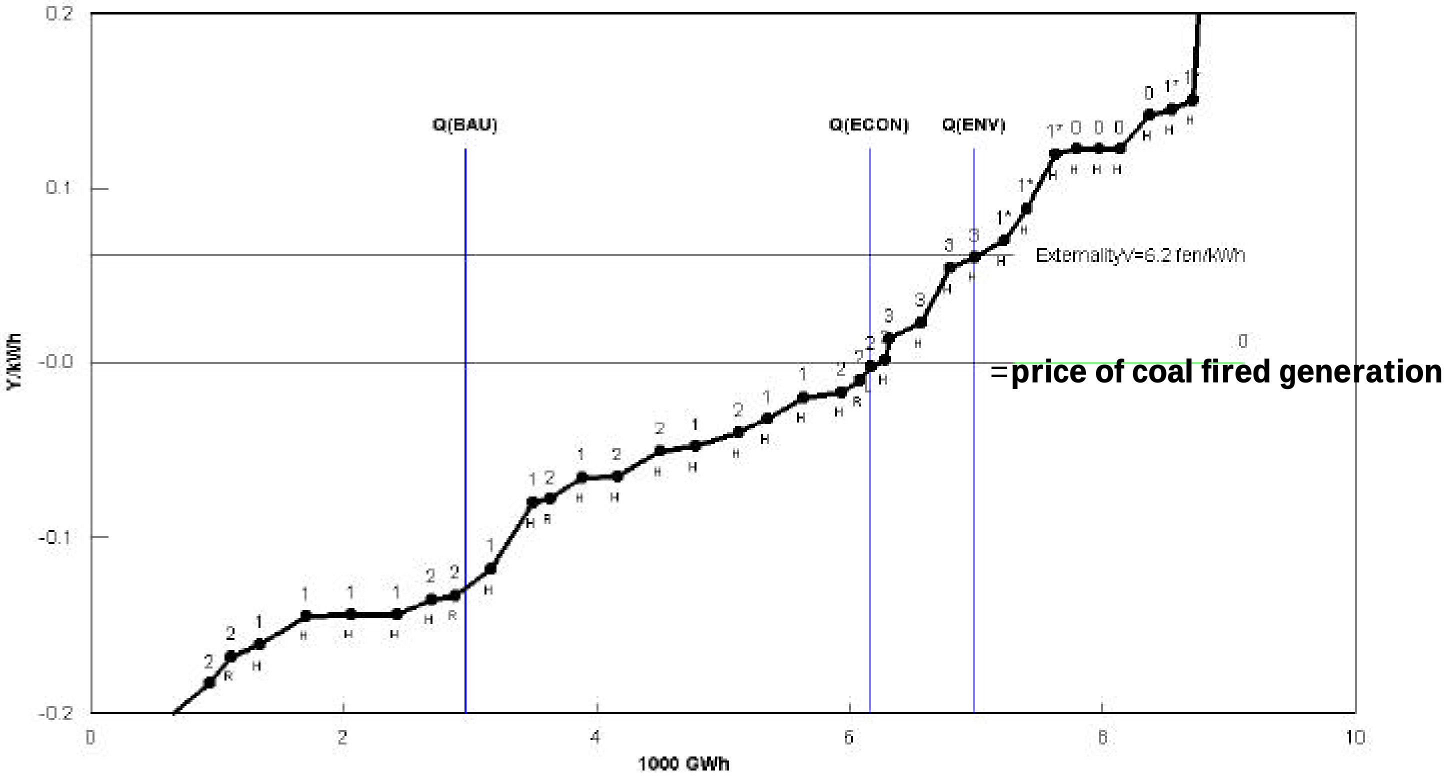
Where this curve intersects the price of coal-fired generation gives the economically optimal quantity.



- When the damage costs are added to the coal generation cost, economically optimal quantities increase



Provincial example: Zhejiang



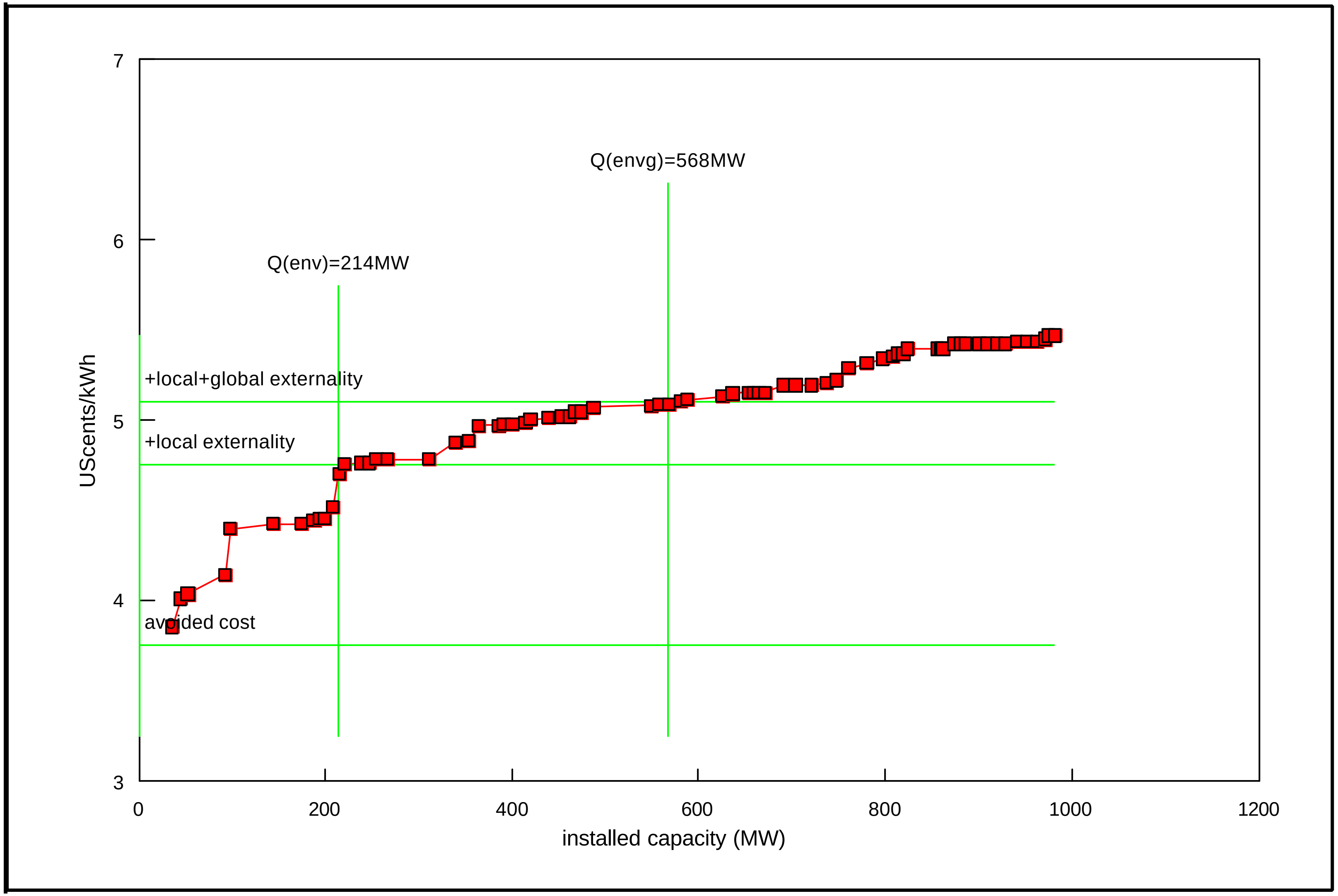
Key: H=small hydro,R=small hydro Rehab,L=landfill gas; W=wind,B=bagasse
1=BAU; 2=economic; 3=justfied by externality value; 0=uneconomic; 1*=uneconomic BAU

		Q[bau]	dQ[econ]	Q[econ]	dQ[env]	Q[env]	Q[prog]
energy	[GWh]	2966	3194	6160	834	6994	4028
capacity	[MW]	610	608	1218	249	1467	857
economic							
incremental benefit(cost)	[Ymillion	294	345	639	-31	608	314
environmental benefit	[Ymillion	183	197	379	51	431	248
net benefit	[Ymillion	476	542	1018	20	1038	562

!

Supply curves as a useful tool for planning: Croatia

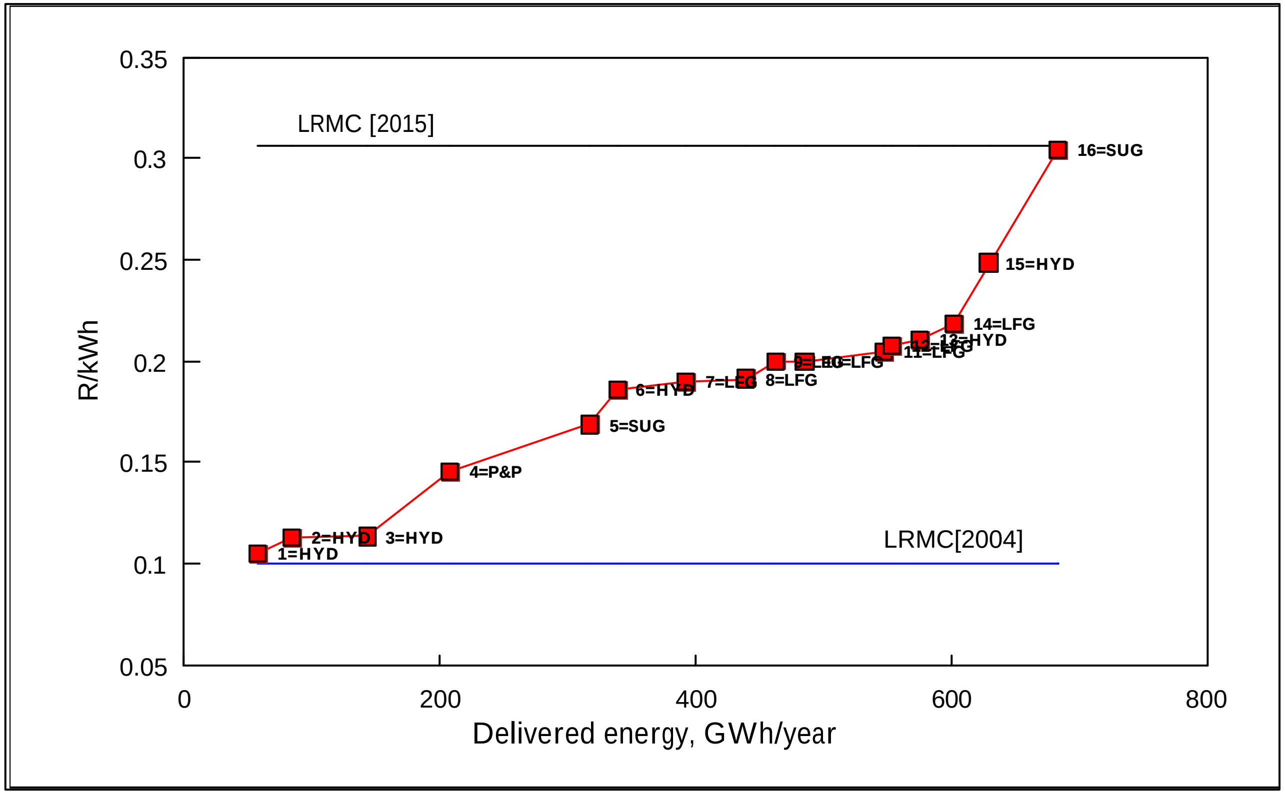
supply curve for wind projects



Supply curves as a useful tool: South Africa

- In South Africa, the supply curve of identified projects was used to set targets for the REMT project
- South Africa is a particularly difficult environment for grid-connected projects, because of very low pool prices (a consequence of ESKOM over –capacity).

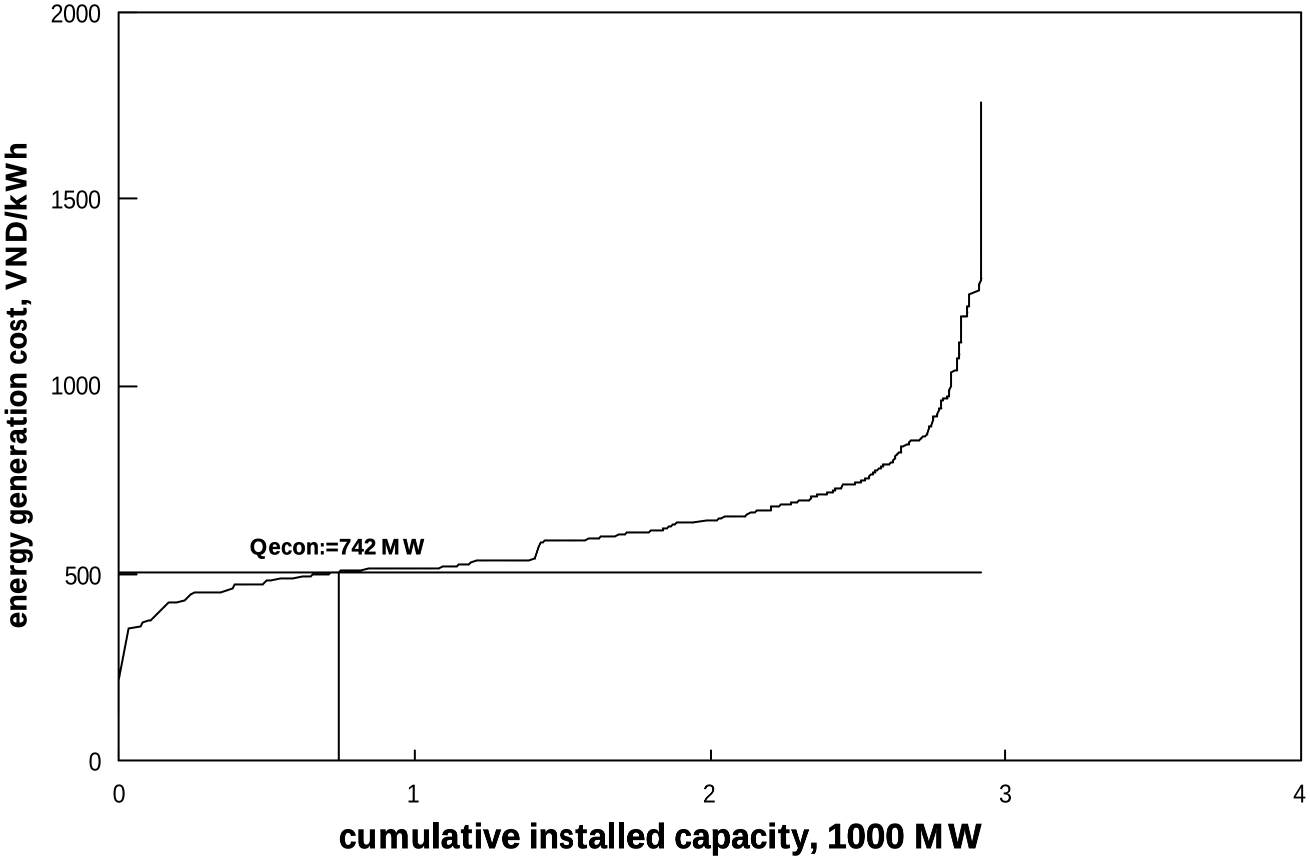
Supply curve of identified projects



Source: World Bank, Economic Analysis for the Renewable Energy Market Transformation Project (REMT)

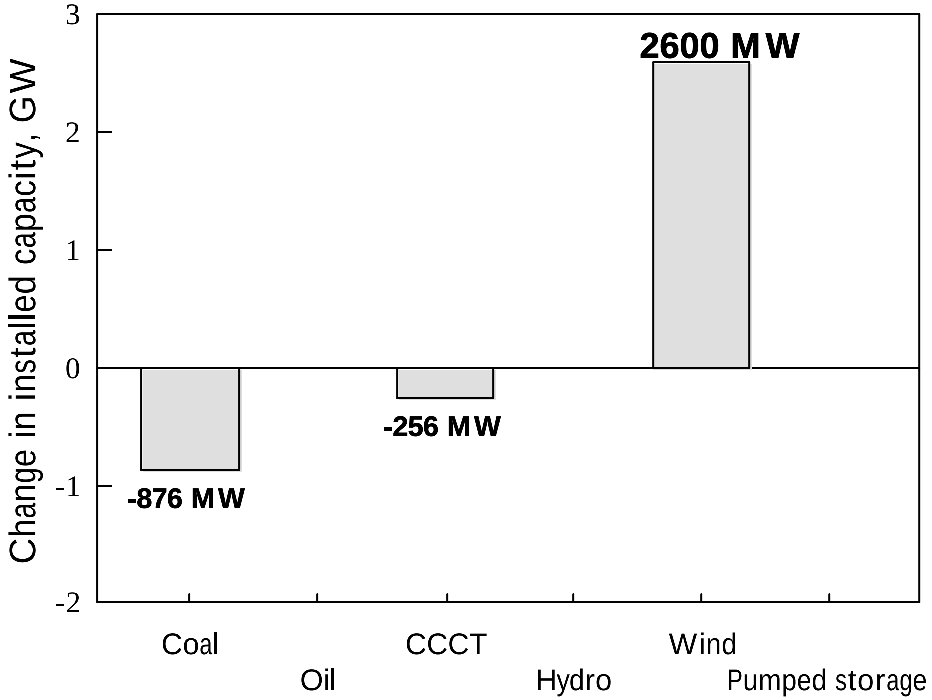
Small hydro supply curve for Vietnam: energy

Supply curve analysis in Vietnam used as a basis for a new World Bank lending programme (to extend loan tenors in the banking system to permit private sector financing of SHPs)

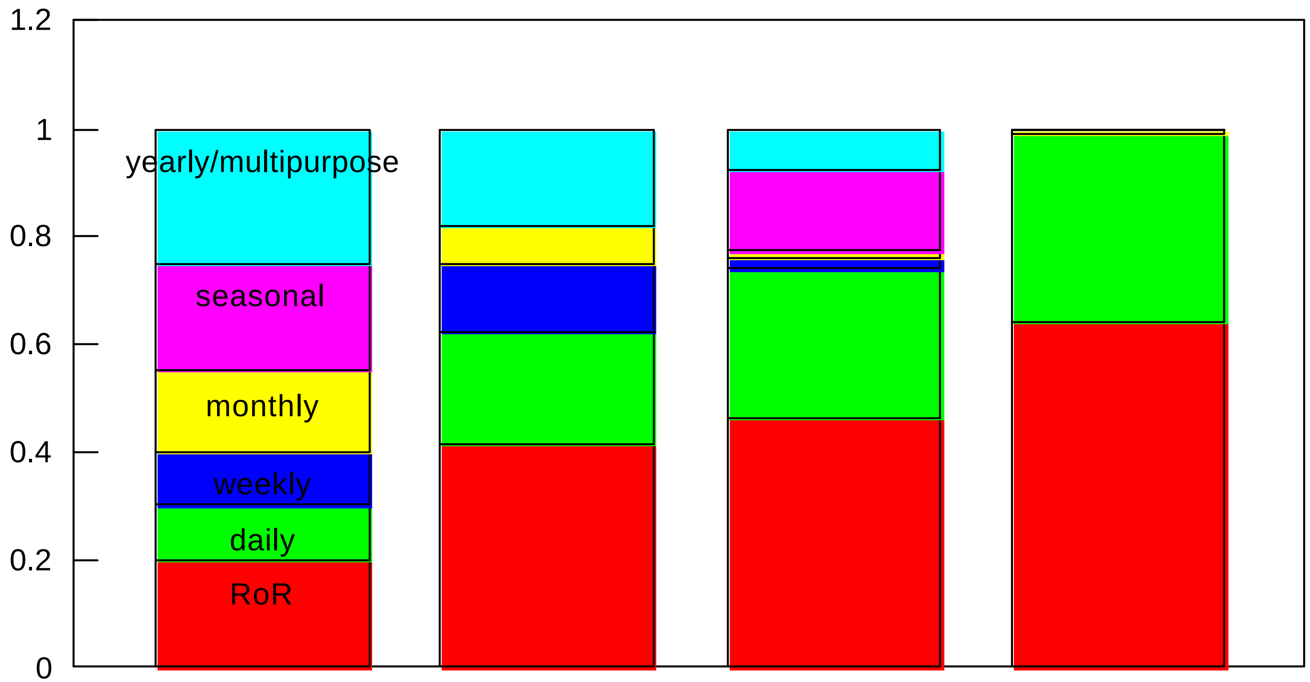


Realities

- Capacity credits from non-dispatchable RE are modest
- Capacity expansion optimization models showed 2600 MW of wind in Inner Mongolia displaced only 880 MW of coal and 250 MW of CCCT



Only few provinces have much storage in small hydro projects

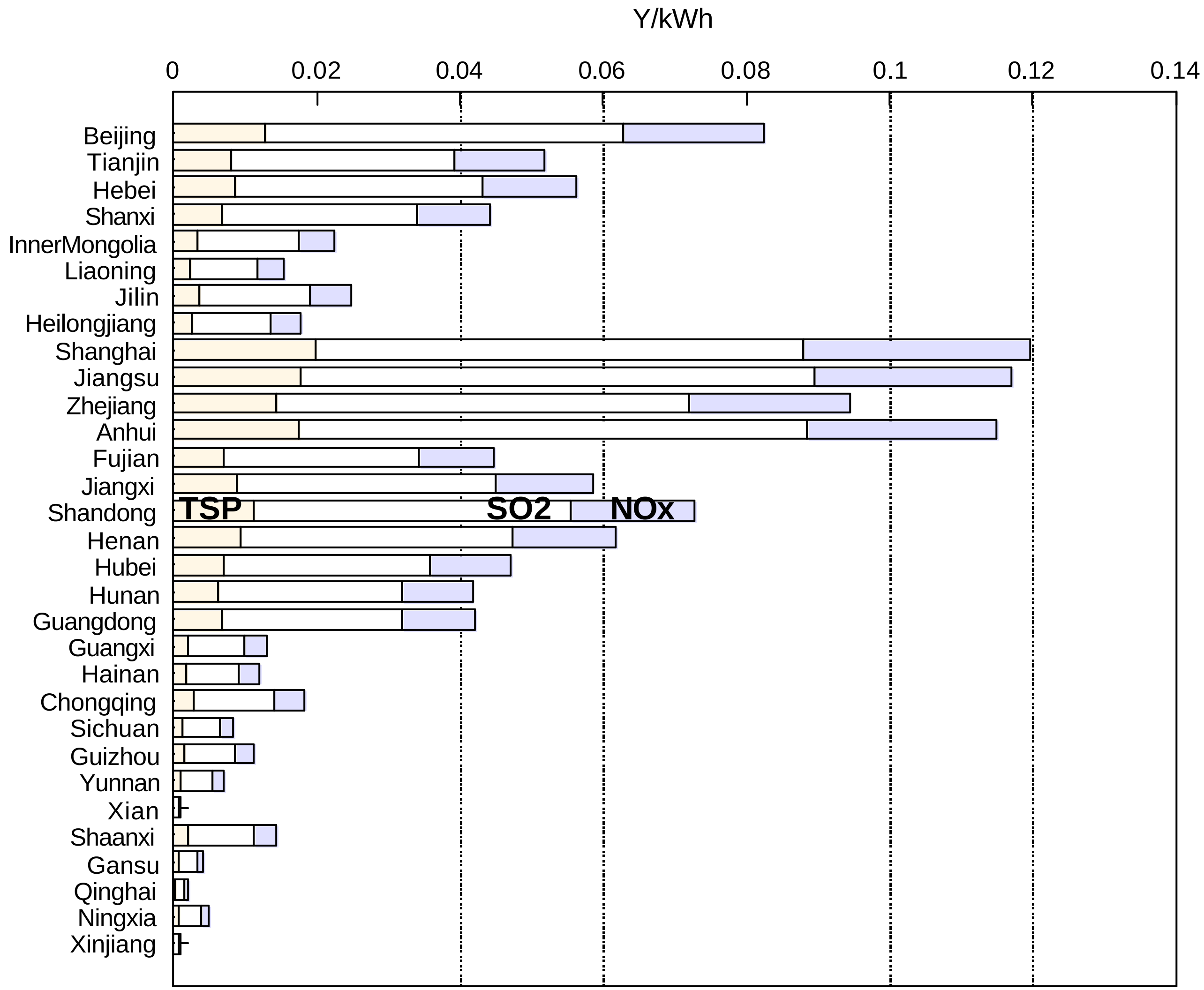


	Zhejiang	Hunan	Guizhou	Sechuan
RoR	20.0%	41.3%	46.2%	64.0%
daily	10.0%	21.1%	27.7%	35.0%
weekly	10.0%	12.6%	2.0%	
monthly	15.0%	6.8%	1.4%	1.0%
seasonal	20.0%		15.0%	
yearly/multipurpose	0.25	0.182	0.077	0

In most provinces, small hydro is mainly pure RoR, with insufficient pondage even for daily peaking operation

Large variations in damage costs

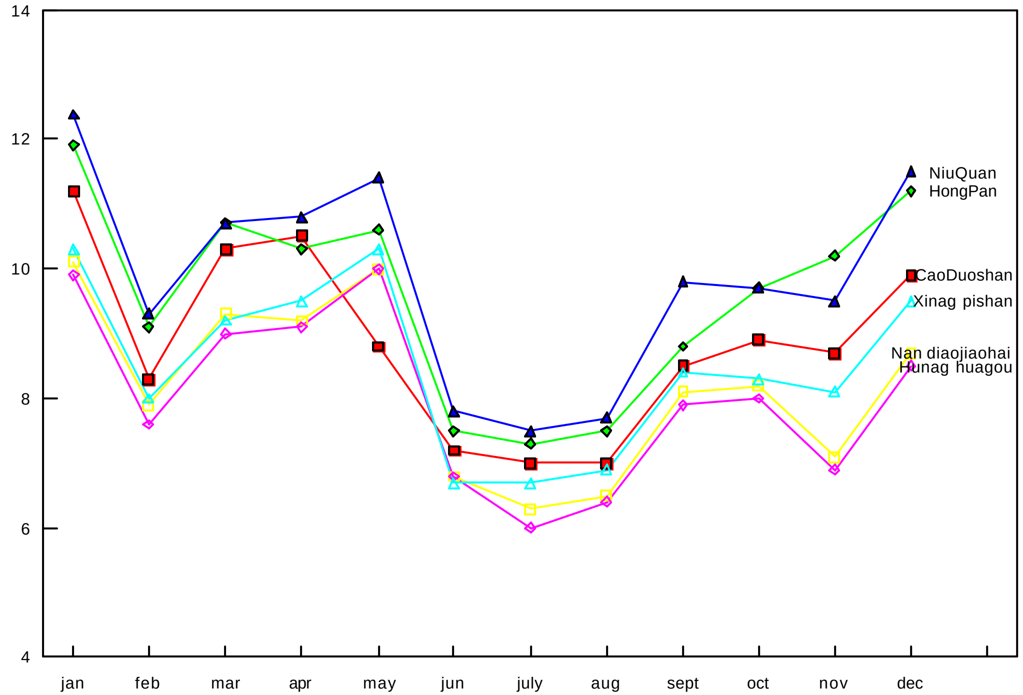
- Provinces with rich RE resources have low damage costs!



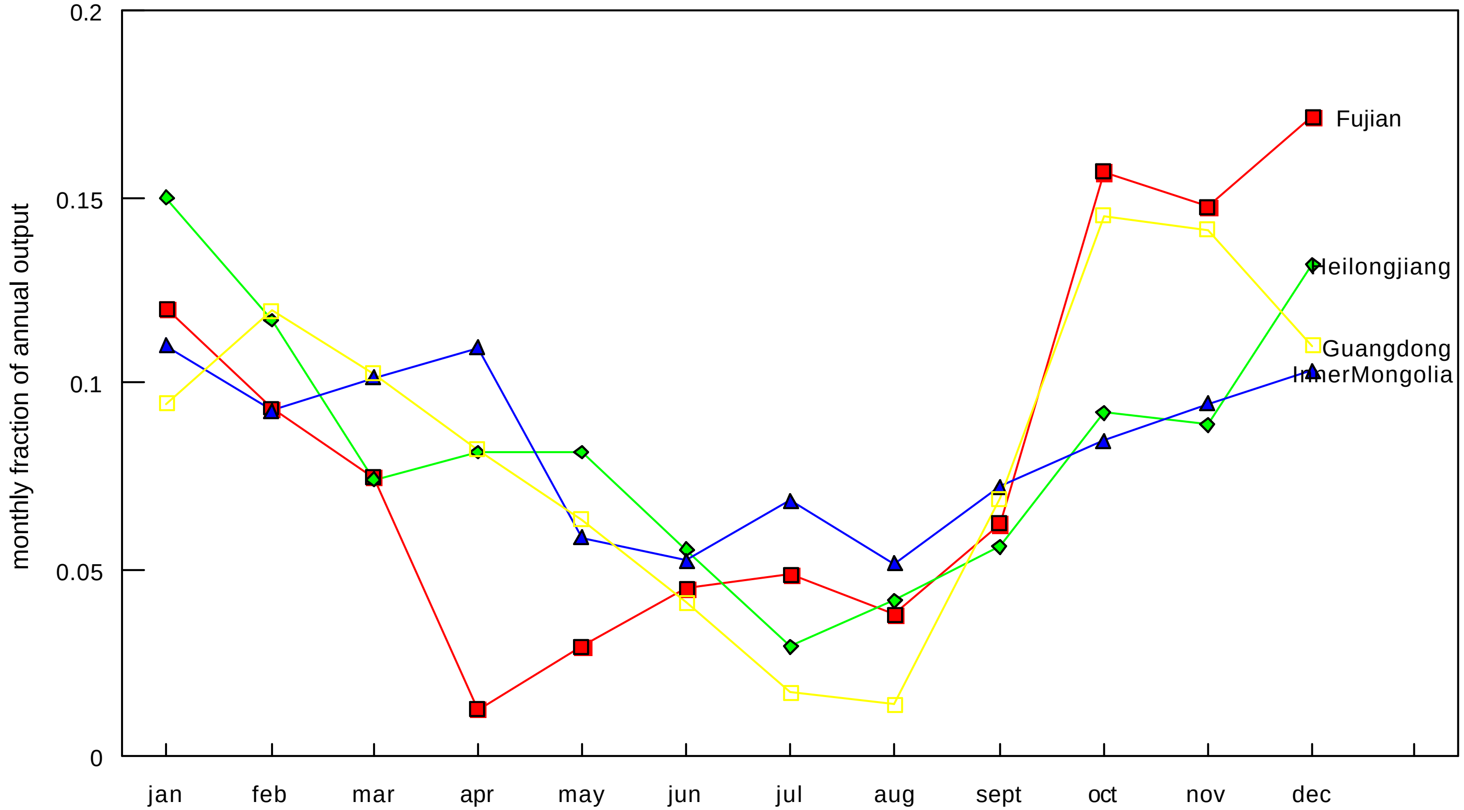
Lessons of the analytical work

Lesson 1 Limited spatial diversity for individual renewable energy technologies

Wind speed variations at six different sites in Inner Mongolia

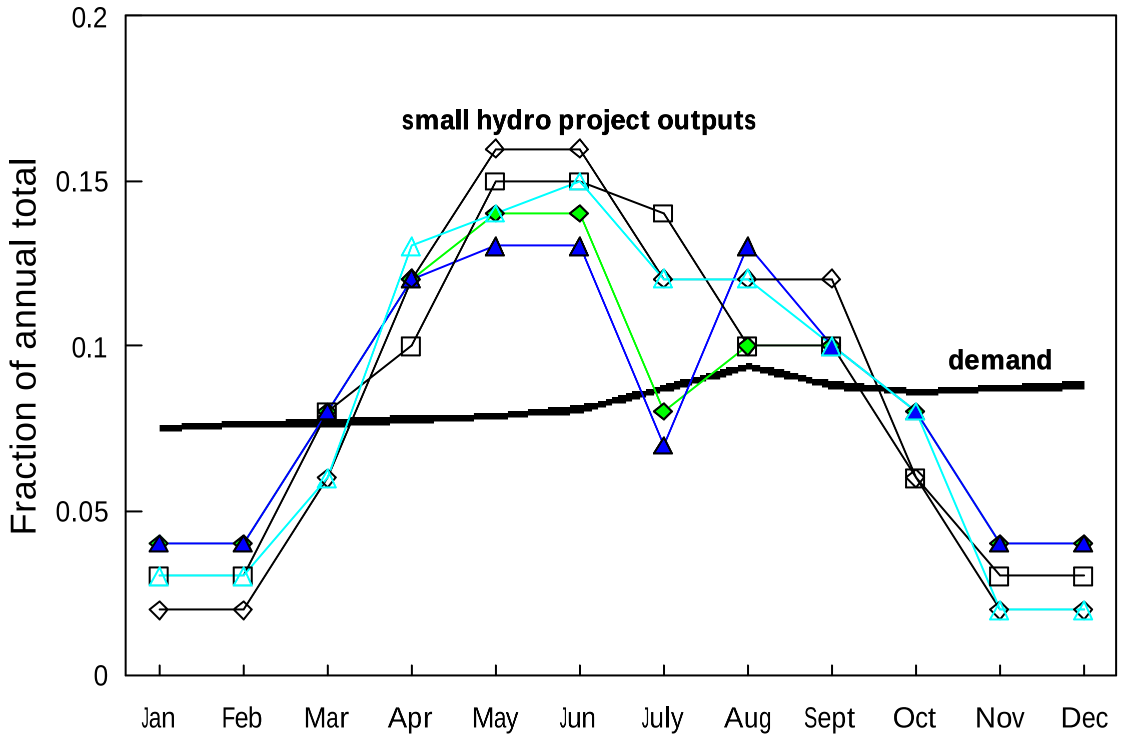


Average wind project output in four different provinces

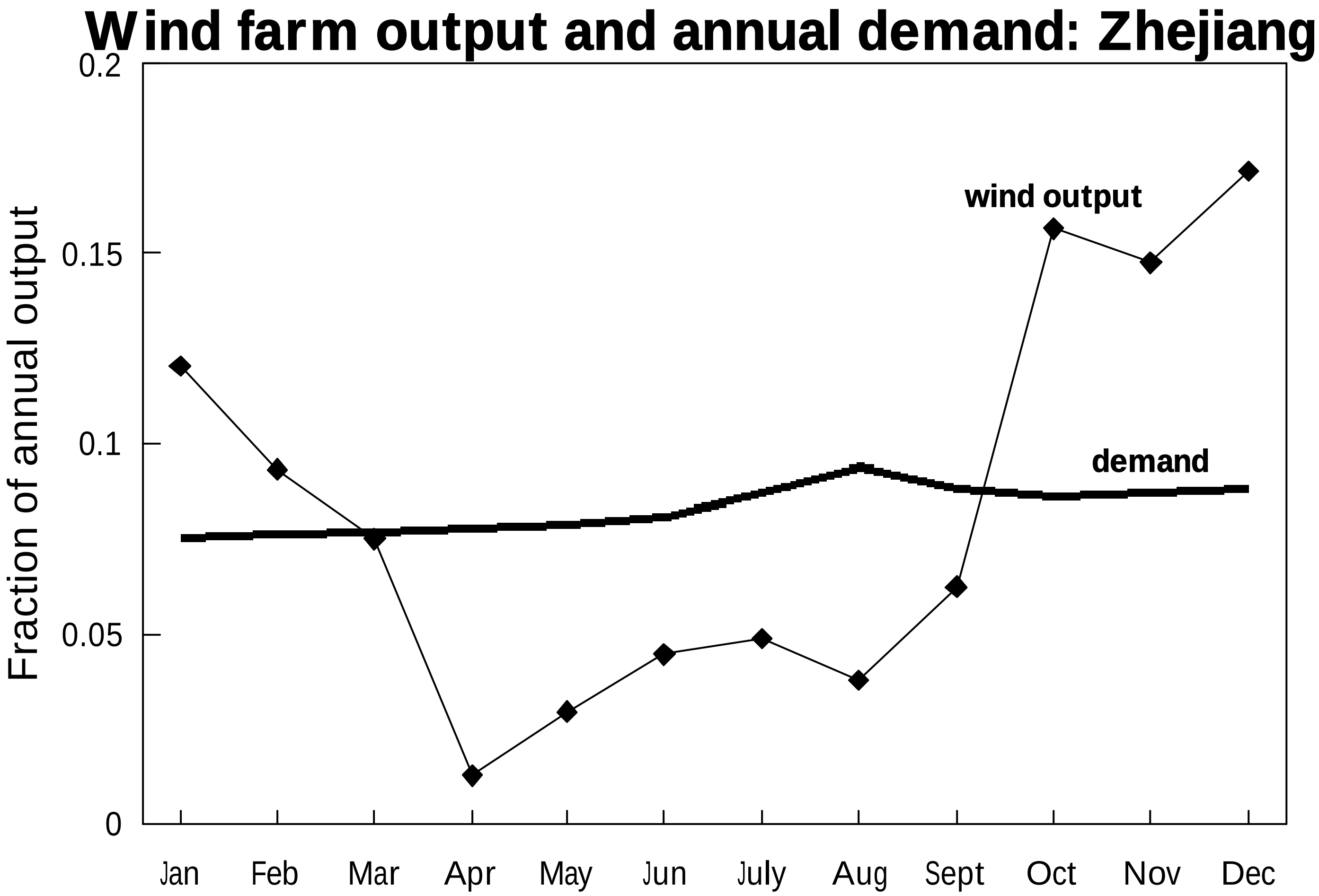


Lesson 2: Conventional models may have limited ability to realistically portray renewables, particularly with respect to Portfolio effects

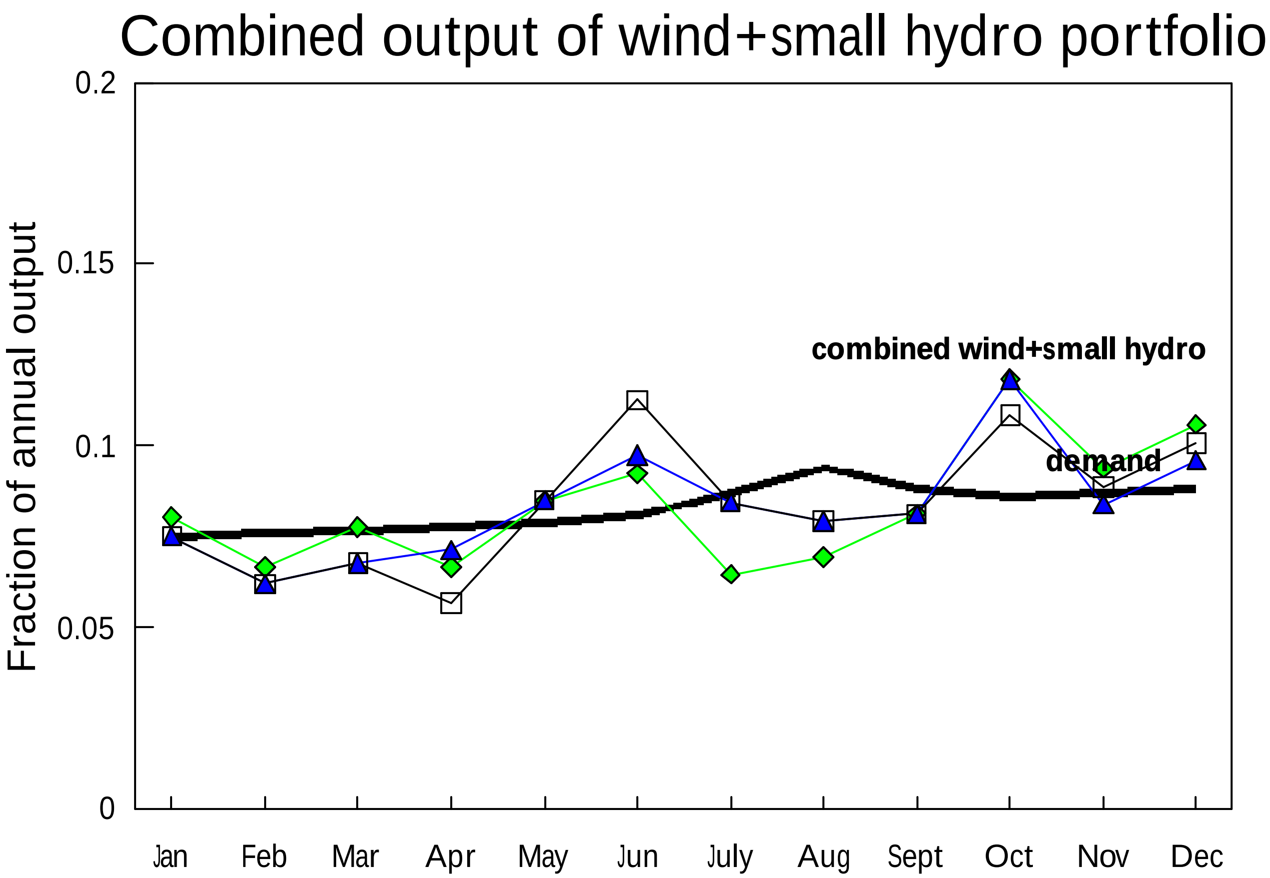
Seasonality of small hydro production: Zhejiang Province



Typical small hydro projects poorly matched with monthly load curve!

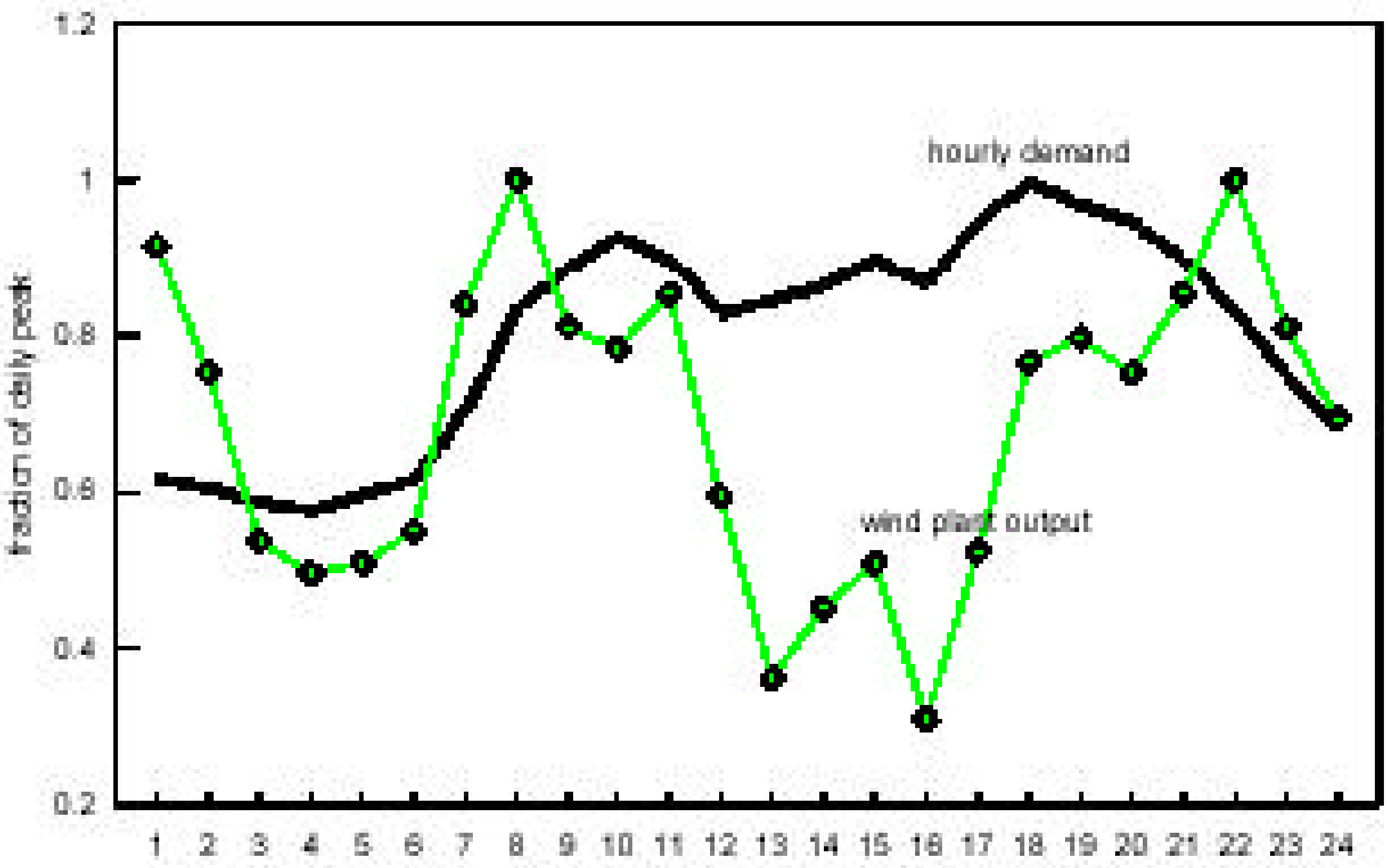

Wind farm output and annual demand: Zhejiang
Fraction of annual output
0.2
0.15
0.1
0.05
0
wind output
demand
Jan
Feb
Mar
Apr
May
Jun
July
Aug
Sept
Oct
Nov
Dec

Yet a *portfolio of both small hydro* + *wind* is well matched to seasonal demand!

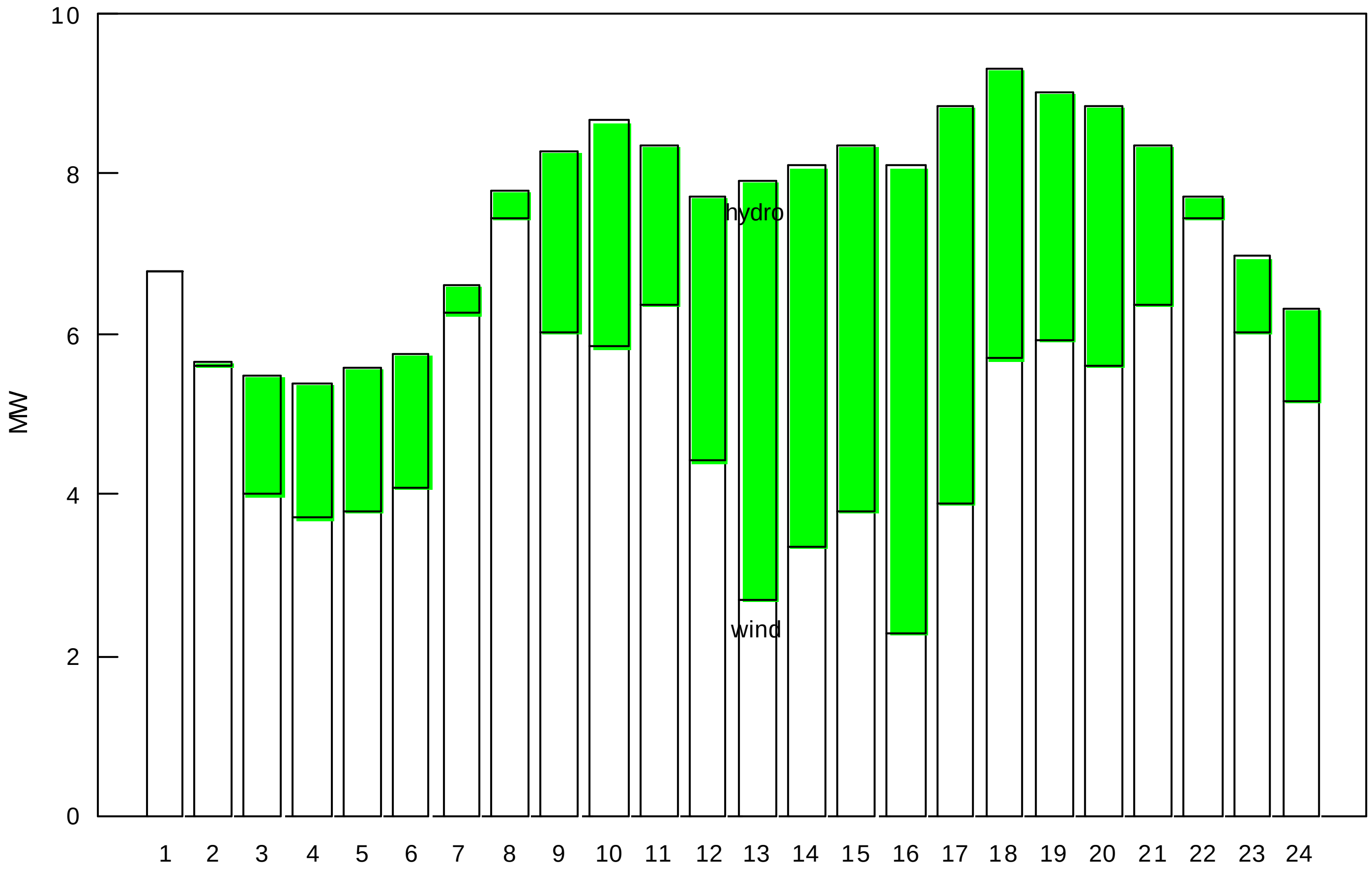


But can the hourly load curve be matched?

Zhejiang hourly wind generation and load curve



Combined output of 10MW small hydro (Shaban) plus 10MW wind matching typical Zhejiang hourly load curve (maximum 9.3MW at 18.00pm)



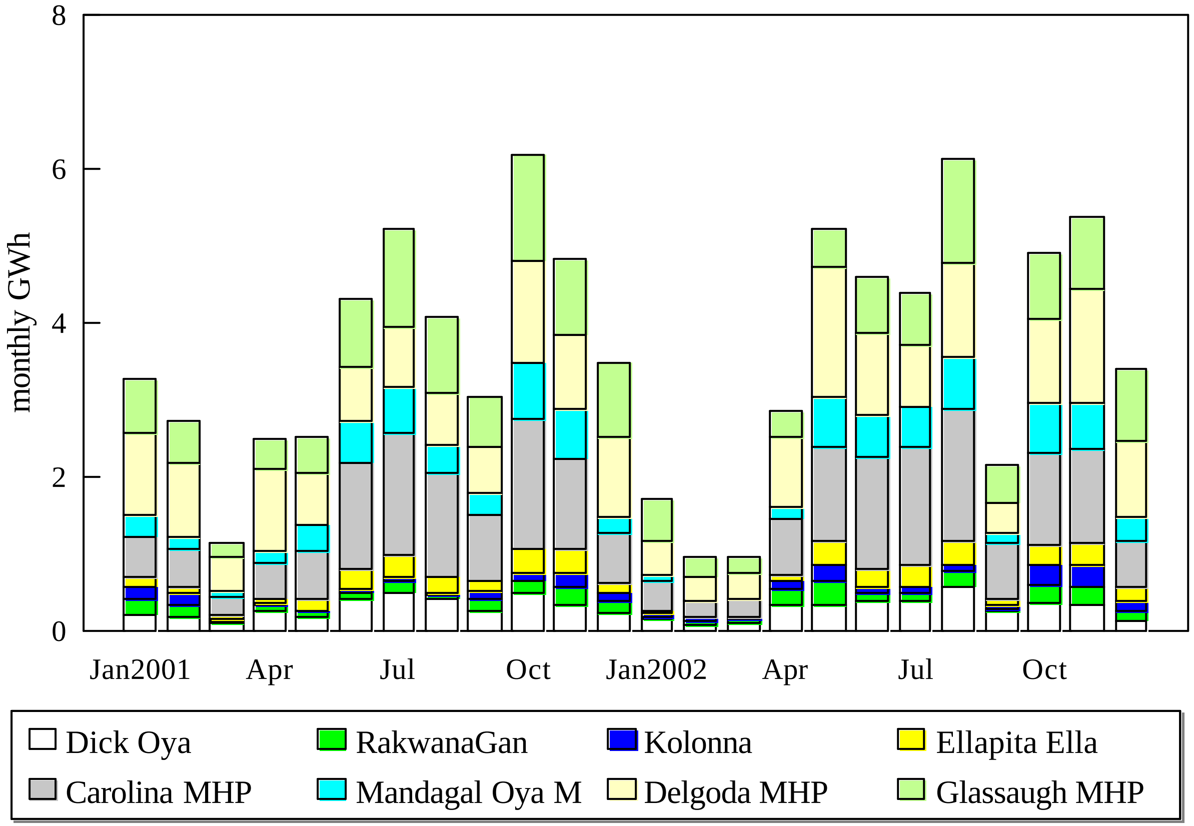
Conclusion: ***Need hourly chronological production simulation model to properly assess portfolio effects***.

Diversity effects in other countries: Sri Lanka small hydro

Variation in monthly output of individual SHPs

	Average monthly generation, m	*Standard deviation, s*	*Coefficient of variation= s/m*
Dick Oya	0.30	0.13	0.44
RakwanaGan	0.13	0.08	0.59
Kolonna	0.11	0.08	0.72
Ellapita Ella	0.18	0.11	0.61
Carolina MHP	0.93	0.48	0.52
Mandagal Oya MHP	0.33	0.23	0.69
Delgoda MHP	0.88	0.35	0.40
Glassaugh MHP	0.68	0.35	0.51
Average of individual plants			0.56
Total generation (=input to CEB)	***3.69***	***1.54***	***0.43***

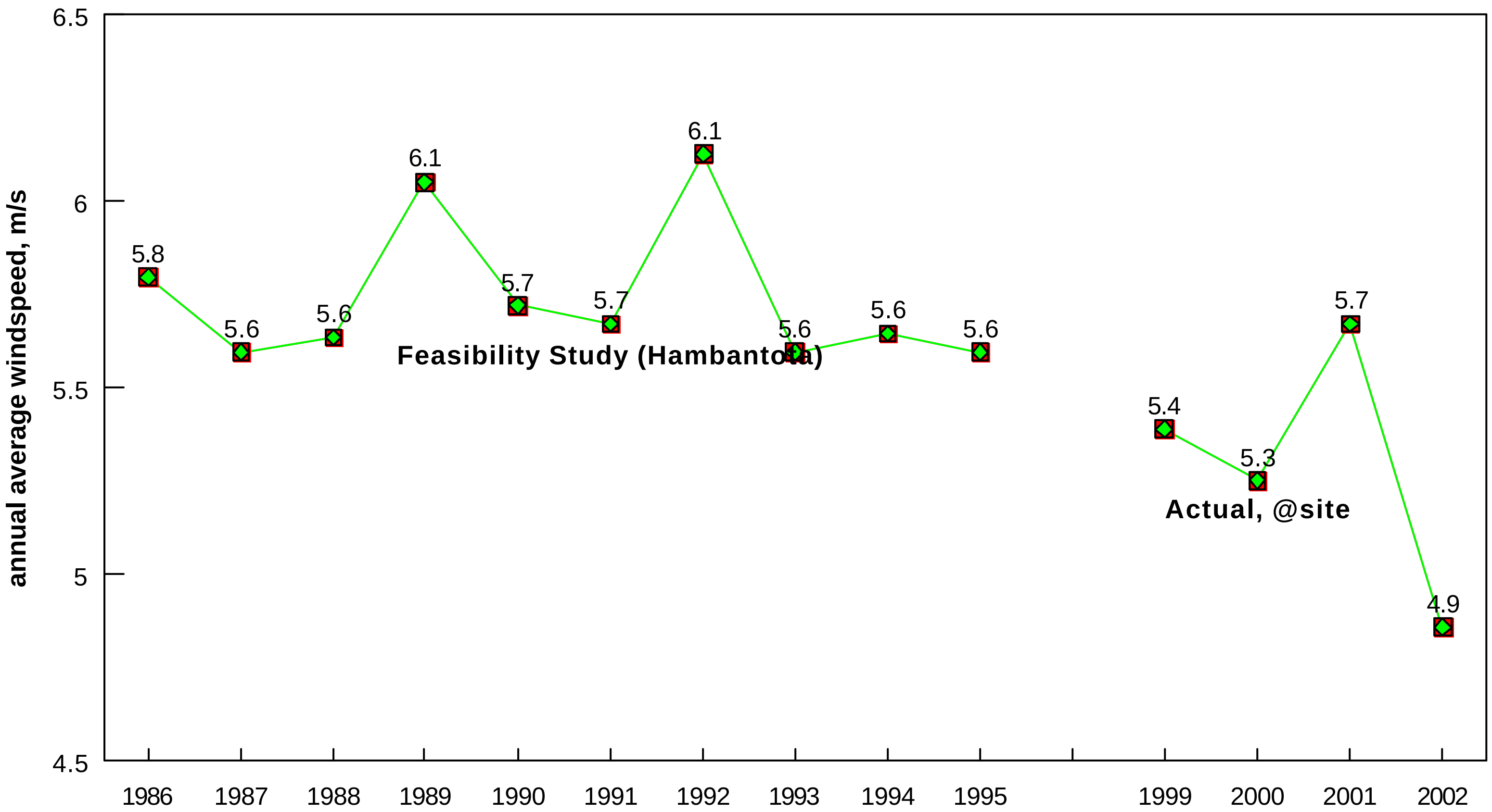
In Sri Lanka, small hydro benefits from a tariff based on avoided marginal costs only, with no capacity credit.



The capacity credit of the portfolio is greater than that of individual projects; and the capacity credit for the portfolio is certainly > zero.

Lesson 3: Wind speed estimates are often optimistic!

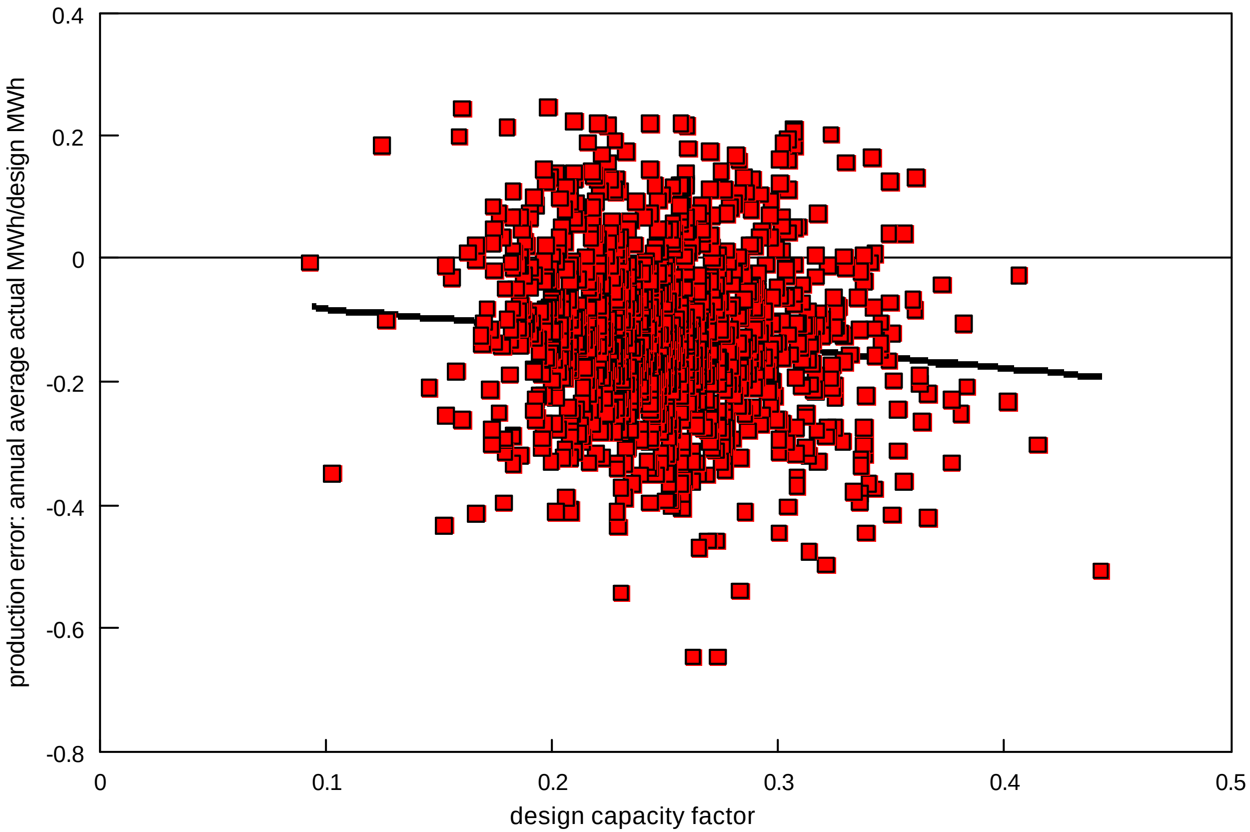
Sri Lanka, experience of the first 3MW wind project demonstration



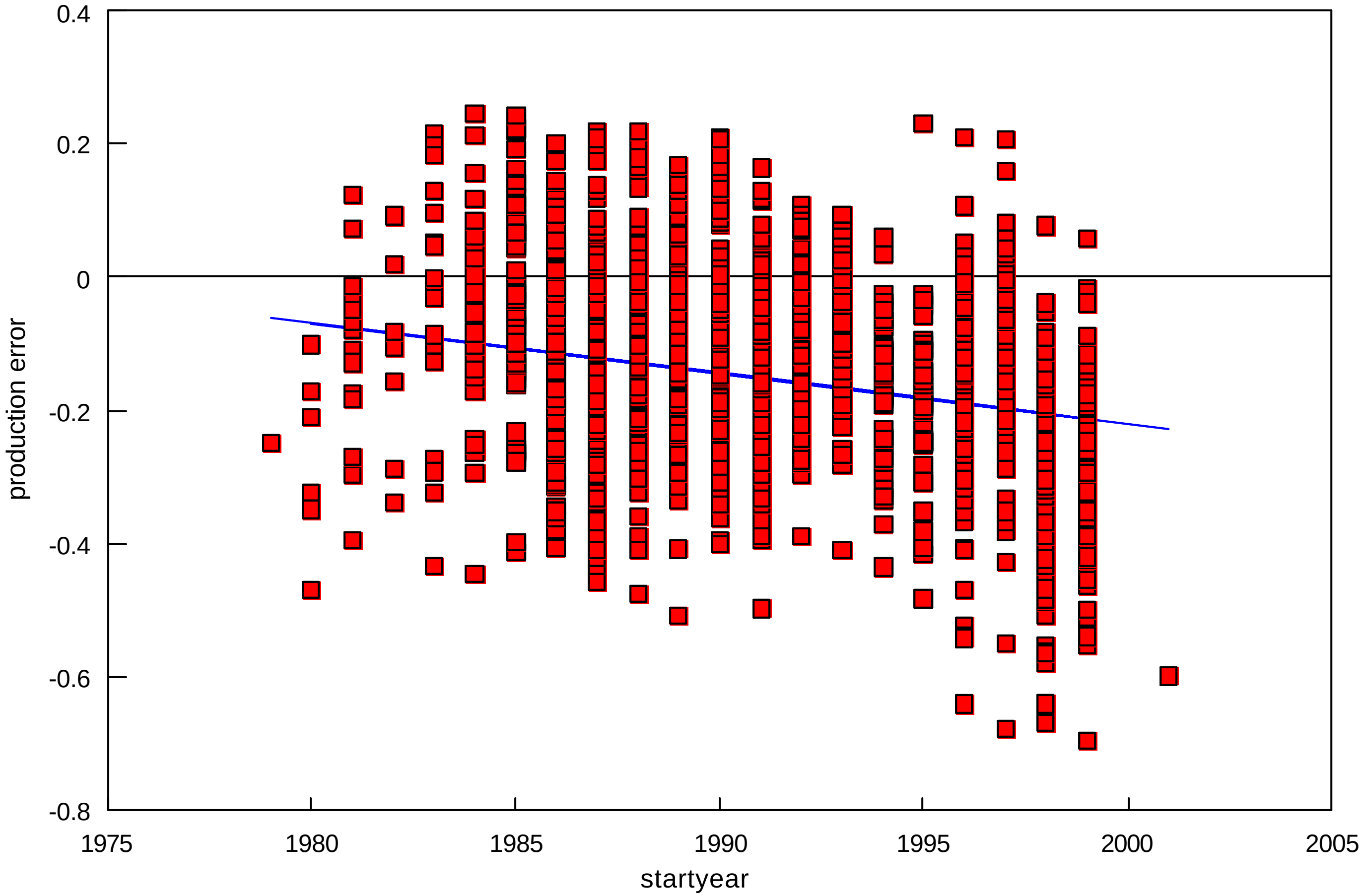
This is not just a problem in China, or in developing countries!

- Windspeed data from the Danish Windstats database: 1080 turbines with more than six years of operating data: actual annual load factor v. capacity factor estimated at design!

- Actual windspeeds on average 12% less than the design estimate!

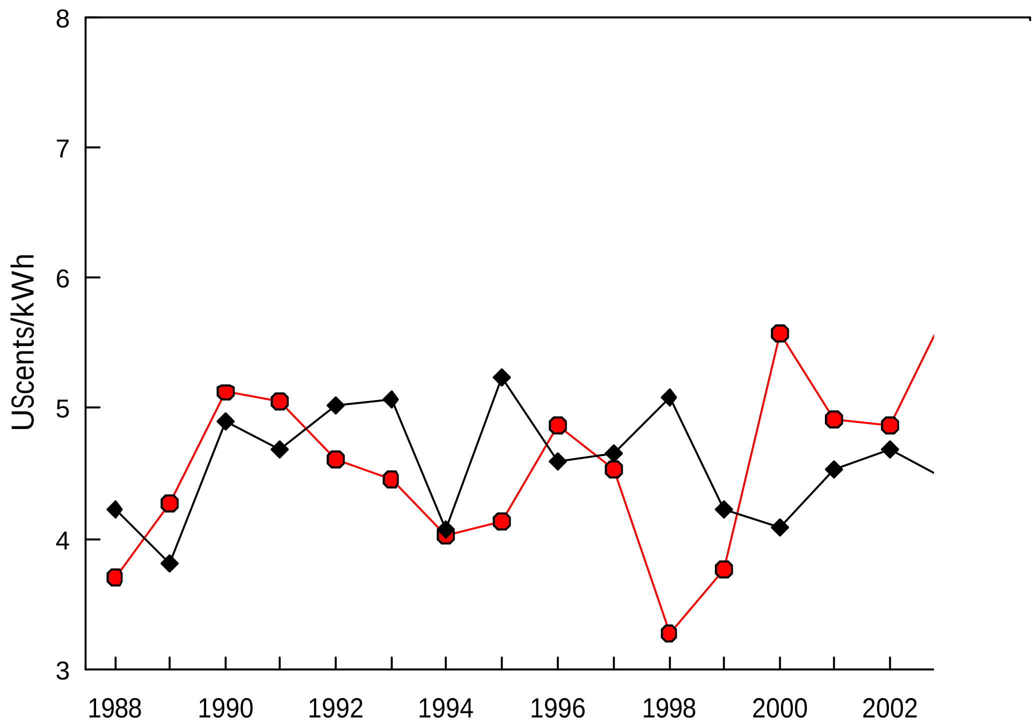


The more recent the commissioning year, the greater the error!

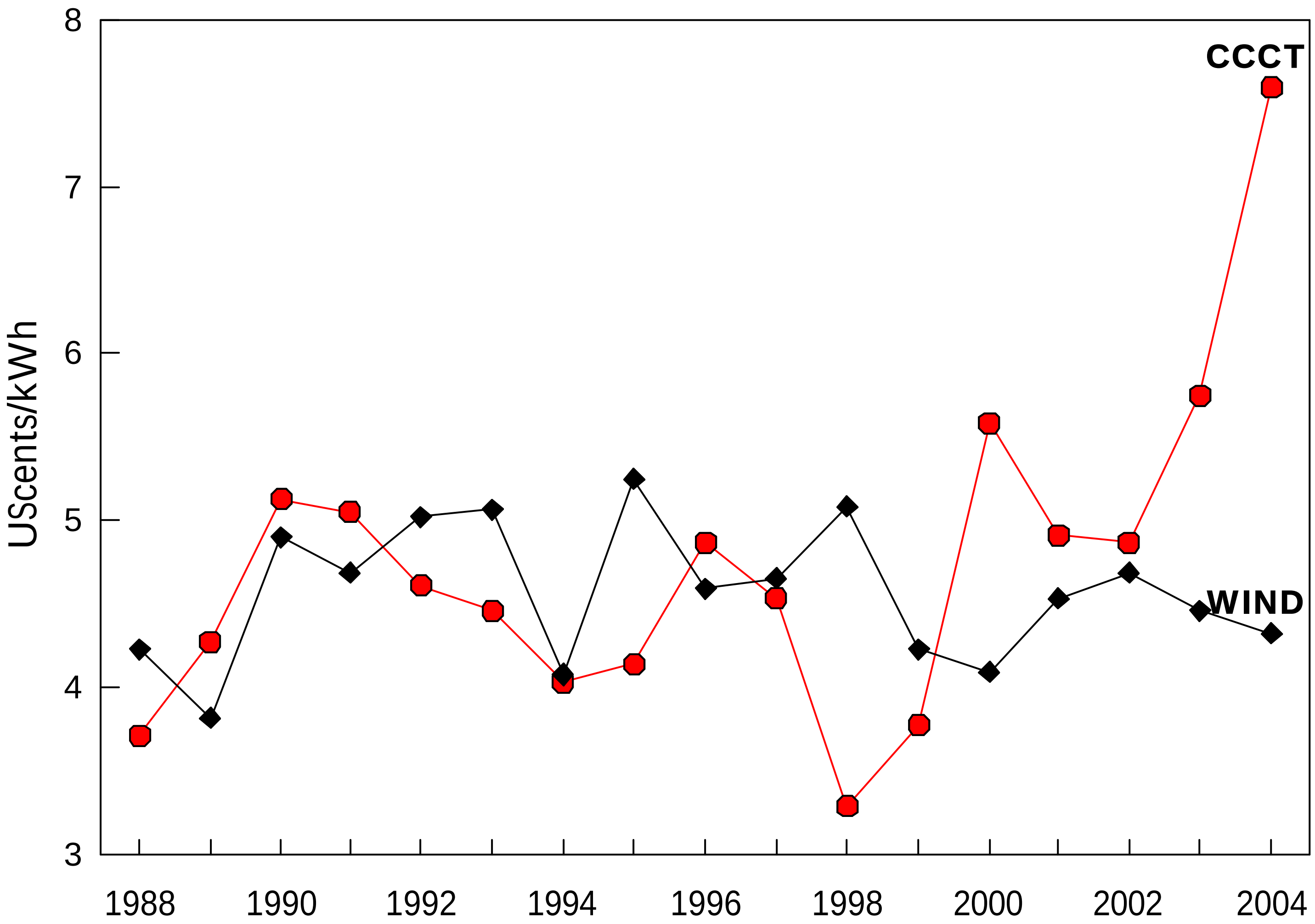


Lesson 4: year-on-year variations are important

Average annual production cost for Sri Lanka CCCT (based on actual variations in auto-diesel prices) and south coast wind farm (based on annual variations in observed wind speeds at Hambantota)



Which is the auto-diesel plant, which is the wind plant?!



CCCT
WIND
UScents/kWh
8
7
6
5
4
3
1988
1990
1992
1994
1996
1998
2000
2002
2004

Implementation issues: key questions

Basic questions:

1. Set price (German feedlaw) and market determines quantity

   or

   Set quantity (Mandated market share) and market determines price

2. Who pays the incremental costs?

3. Who enforces the rules?

Concession Model for wind

- Guaranteed off-take
- Minimum domestic content (70% in 2004)
- Transmission line is the responsibility of the power grid company
- Access road responsibility of the county government
- 25-year concession period
- Minimum turbine size 600kW
- Minimum size 100MW

Wind concession projects

		MW	Bid price Y/kWh	Bid price UScents/kWh
Rudong #1	Jiangsu	100	.4365	5.3
Huilai Shi	Guangdong	100	.5013	6.1
Tongyu A	Jilin	200	.509	6.1
Tongyu B	Jilin	200	.509	6.1
Huitengxile	Inner Mongolia	100	.382	4.6
Ruding 2	Jiangsu	150	.519	6.2

Conclusions: where?

From the perspective of economic efficiency, best locations are not necessarily those with the best resources.

- Inner Mongolia has the best wind resources, but low damage costs, and low coal-fired generation costs, and small proportion of storage hydro
- Eastern coast has high damage costs, high generation costs, medium wind resource, and generally larger proportion of storage hydro.

Conclusions: How much?

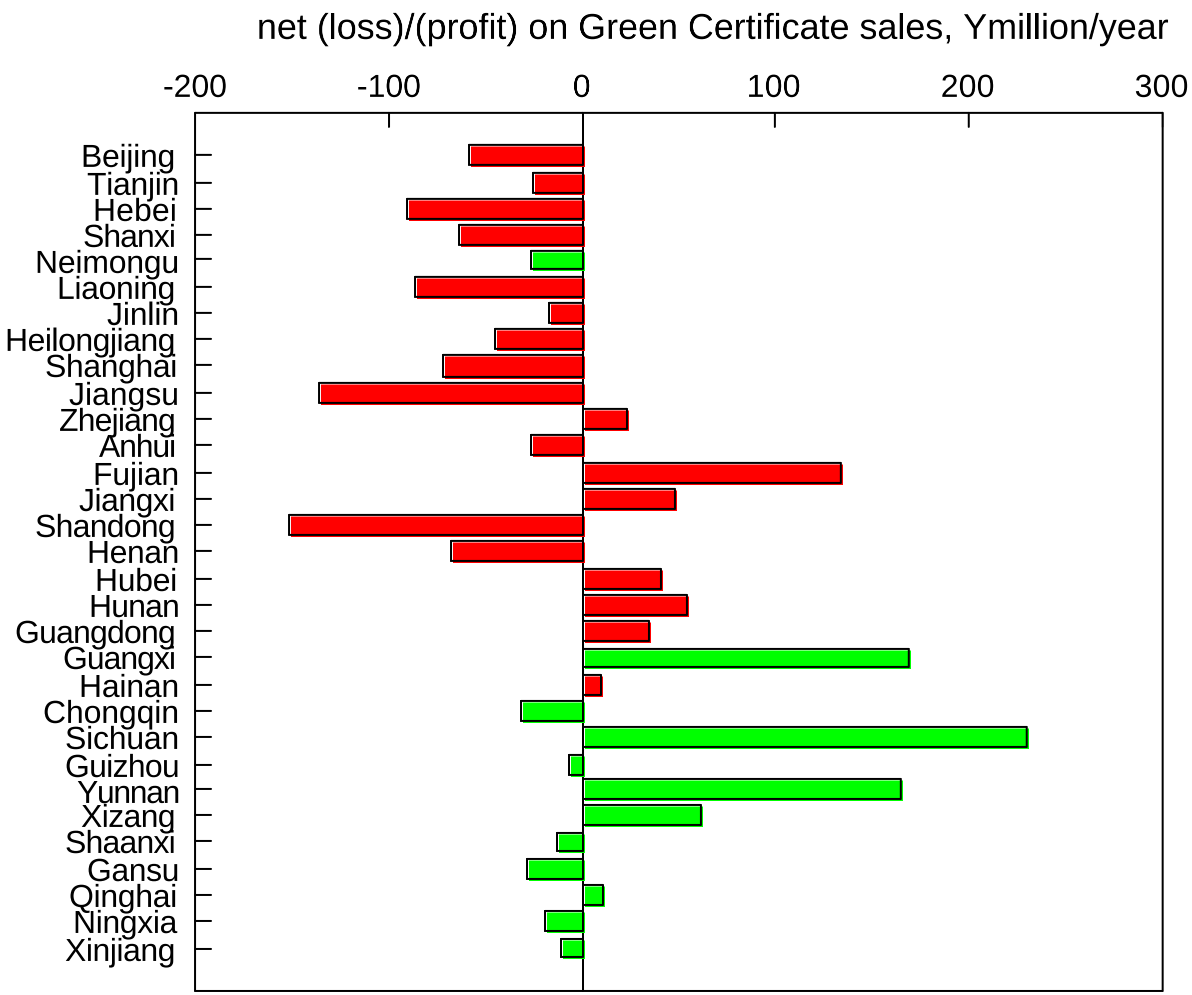
- Based on present estimates of local health damage costs, CRESP estimated that ~4% of 2010 generation, or around 90 TWh, was economically justified (excludes large hydro)

- Recently announced targets are 10% for 2020, and 15% (including large hydro)

Conclusions: How?

- Western region development best promoted by tradable green certificates

Red=east
Green=west



Losers winners

Conclusions: Who enforces?

The Renewable Energy Law is *enabling* legislation that is mainly a statement of Government intent.

Implementing rules and regulations devolved to the NDRC (National Development and reform Commission) and to the Provincial entities.

Conclusions: Who Pays

The first set of rules implementing the RE law " Trial Measures for Pricing and Cost Sharing Management for renewable Energy Power" issued earlier this year.

- *Hydropower* shall be implemented according to existing provisions (which means provincial schemes, such as Zhejiang's bidding scheme for small hydro concessions, left unchanged).
- The price difference between RE power and the cost of power generation from coal fired projects with FGD shall be shared across power sales at the provincial level and above nationwide
- Agricultural power users, Tibet, and cities and counties with their own power grids are exempt from the surcharge
- Power price for wind projects to be set by bidding ("government guided pricing")
- Power price for biomass, geothermal, etc. set by "government fixed pricing"

Status of CRESP

Capacity building, institutional strengthening, and implementing the Renewable Energy Law to be piloted at the *provincial* level

Four pilot provinces (each with its own investment component)

- Fujian (wind)
- Jiangsu (Biomass power plant 110t/h straw-fired boiler, 25MW)
- Zhejiang (small hydro rehabilitation)
- Inner Mongolia (wind)

Will China attain its renewable energy target?