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RENEWABLE ENERGY INSTITUTE

Connecting Asia with Renewables Asia Super Grid Concept

自然エネルギーでアジアをつなぐ
アジアスーパーグリッド構想

Mika Ohbayashi, Director, Renewable Energy Institute

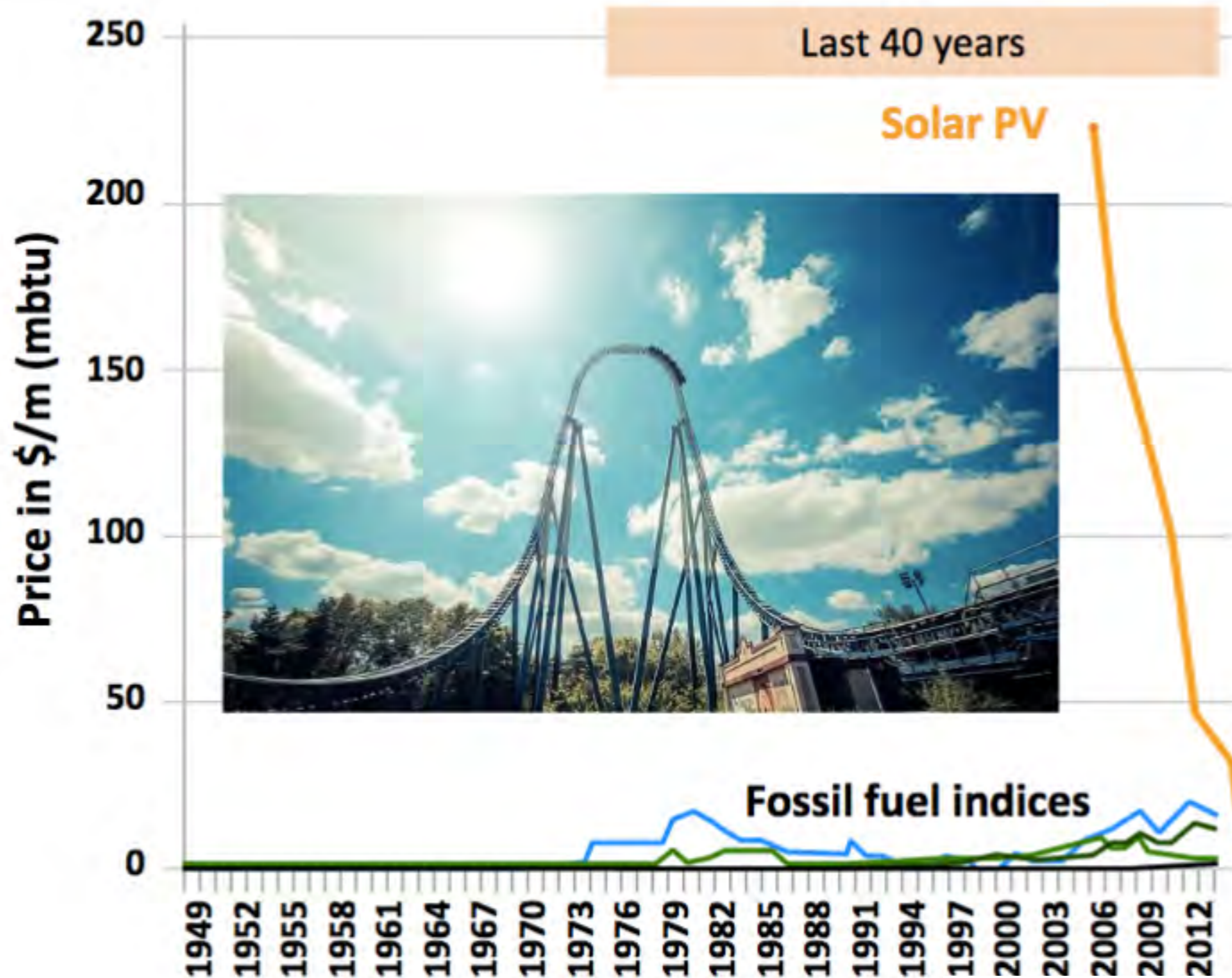
大林ミカ 事業局長 自然エネルギー財団

Three REvolutions are Coming



- 1. Cost of renewables are declining**
2. Cost of batteries are declining
3. HVDC are becoming cheap and expanding

Three REvolutions are Coming



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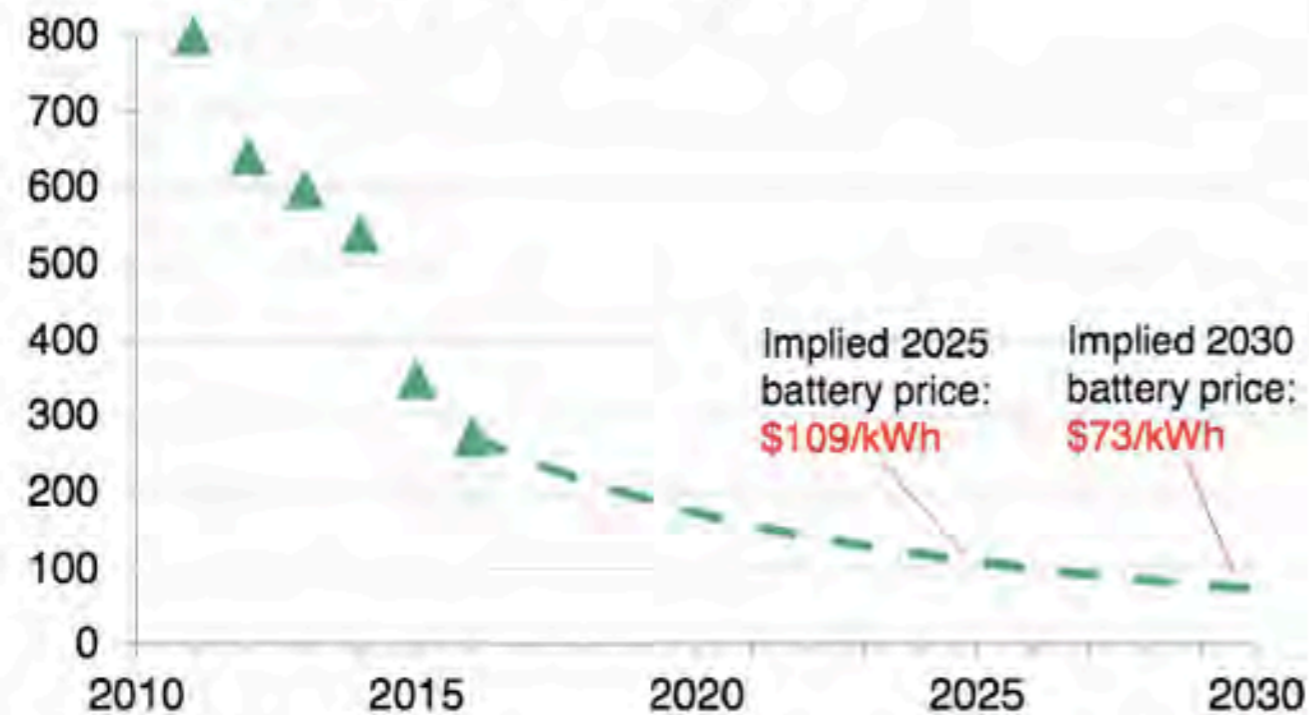
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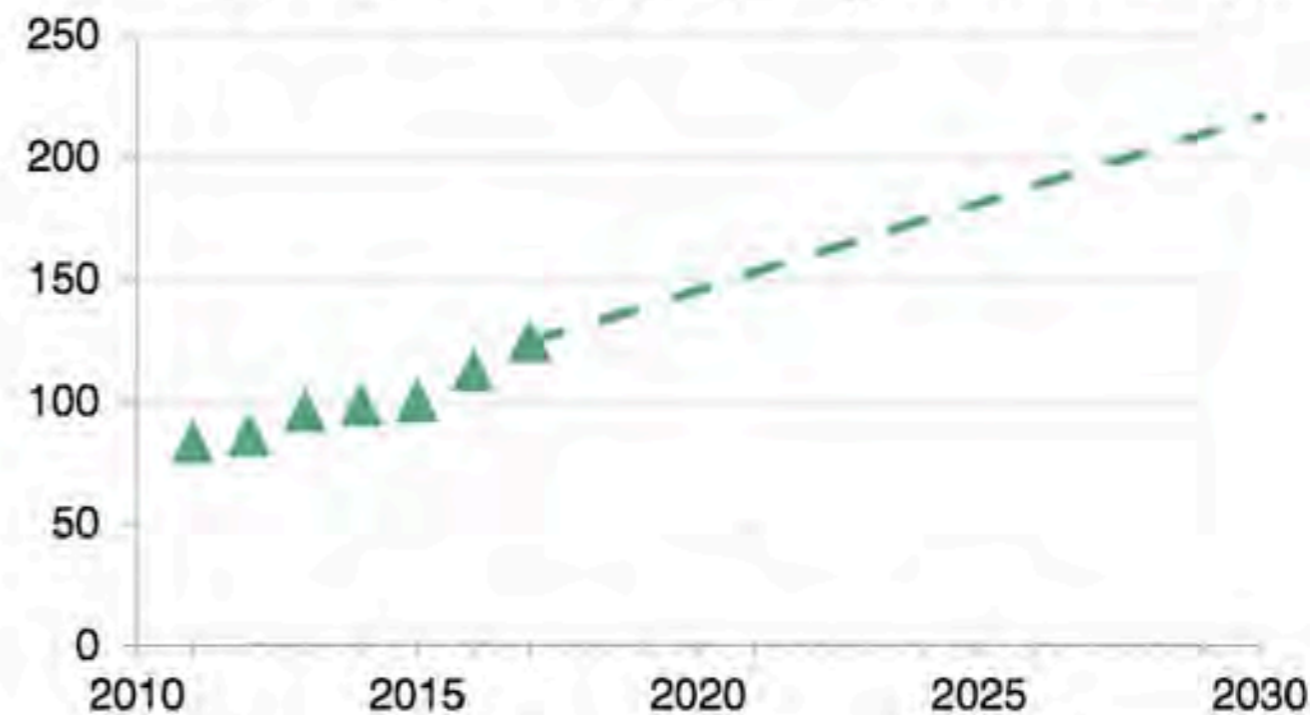


Batteries only becoming better -prices and quality

Falling Prices (\$/kWh)



Improving Energy Density (Wh/kg)



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HVDC transmission system expanding

【Since 1910s】

- 1915 Denmark-Sweden Interconnection
- 1920 Interconnection between France, Switzerland and Italia.

【After WWII】

- 1951 UCPTTE among 8 countries.
(West-Germany, France, Italy and others)
- 1963

NORDEL in Northern Europe

UFIPTE by France, Spain and Portugal

【Currently】

The region is divided into four synchronous grids, Continental Europe, Nordic, UK, and Baltic, and they are connected asynchronously through direct current transmission, so that electricity trade can be conducted among them.



Figure 5 Power flows between countries in Europe (2015)
Source: ENTSO-e, Statistical Factsheet 2015

Three REvolutions are Coming



HVDC transmission system expanding

NO.	Project		Distance (km)	Strait, etc. (km)	Trans-mission method	Grid voltage (kV)	DC voltage (kV)	Transmission capacity (MW)	Came into operation in	Transformer cost	Transmission line cost	Total cost	¥10,000/ MW km (reference)*
1	SAPEI	Italy	435	420	line-Commutated	400	±500	1,000	2011	\$180m	€400m	€750m	20
2	BritNed	UK - Netherlands	259	250	line-Commutated	400 380	±450	1,000	2011	€220m	\$350m	€600m	26
3	Nemo Link	UK - Belgium	141	130	self-Commutated	400 380	±400	1,000	2019	—	—	€500m	40
4	Estlink 2	Estonia - Finland	171	145	line-Commutated	330 400	450	650	2014	€100m	\$180m	€320m	32
5	NorNed	Netherlands - Norway	583	580	line-Commutated	380 300	±450	700	2008	\$270m	€51m	€600m	17
6	Fenno-Skan 2	Sweden - Finland	196	194	line-Commutated	400	±500	800	2011	\$170m	€150m	€315m	23
7	Skagerak 4	Denmark - Norway	243	140	self-Commutated	400 300	±500	700	2014	\$180m	€87m	—	17
8	Nord.Link	Germany - Norway	623	516	self-Commutated	380 420	±525	1,400	2019	\$900m	€500m	€1.5— 2.0b	20~26

*Converted at ¥114.0/€ and ¥103.8/\$ (forex rates on October 19)

Source: “On Preparation of Long-term Cross-regional Network Development Policy,” Material No. 1 for the 18th Meeting of the Cross-regional Network Development Committee, OCCTO (October 25, 2016, Committee Secretariat)



CHANGE IS RAPID, THAN WE EXPECT

Three REvolutions are Coming



Easter Parades on Fifth Avenue in New York, 13 years apart

1900: where's the first car



1913: where's the last horse?



source: Amory Lovins, Presentation at REI's event in March 2016

Images: L, National Archive, www.archives.gov/research/american-cities/images/american-cities-101.jpg ; R, shorpy.com/node/204.

Inspiration: Tona Seba's keynote lecture at AltCar, Santa Monica CA, 28 Oct 2014, <http://tonyseba.com/keynote-at-altcar-expo-100-electric-transportation-100-solar-by-2030/>

고마웠습니다

Paradigm Shift in Energy - Peace for Asia



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