March 10, 2012

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shaping tomorrow with you

A Vision of Power System after 3.11

Paradigm Shift from Central Control to Decentralized-Autonomous

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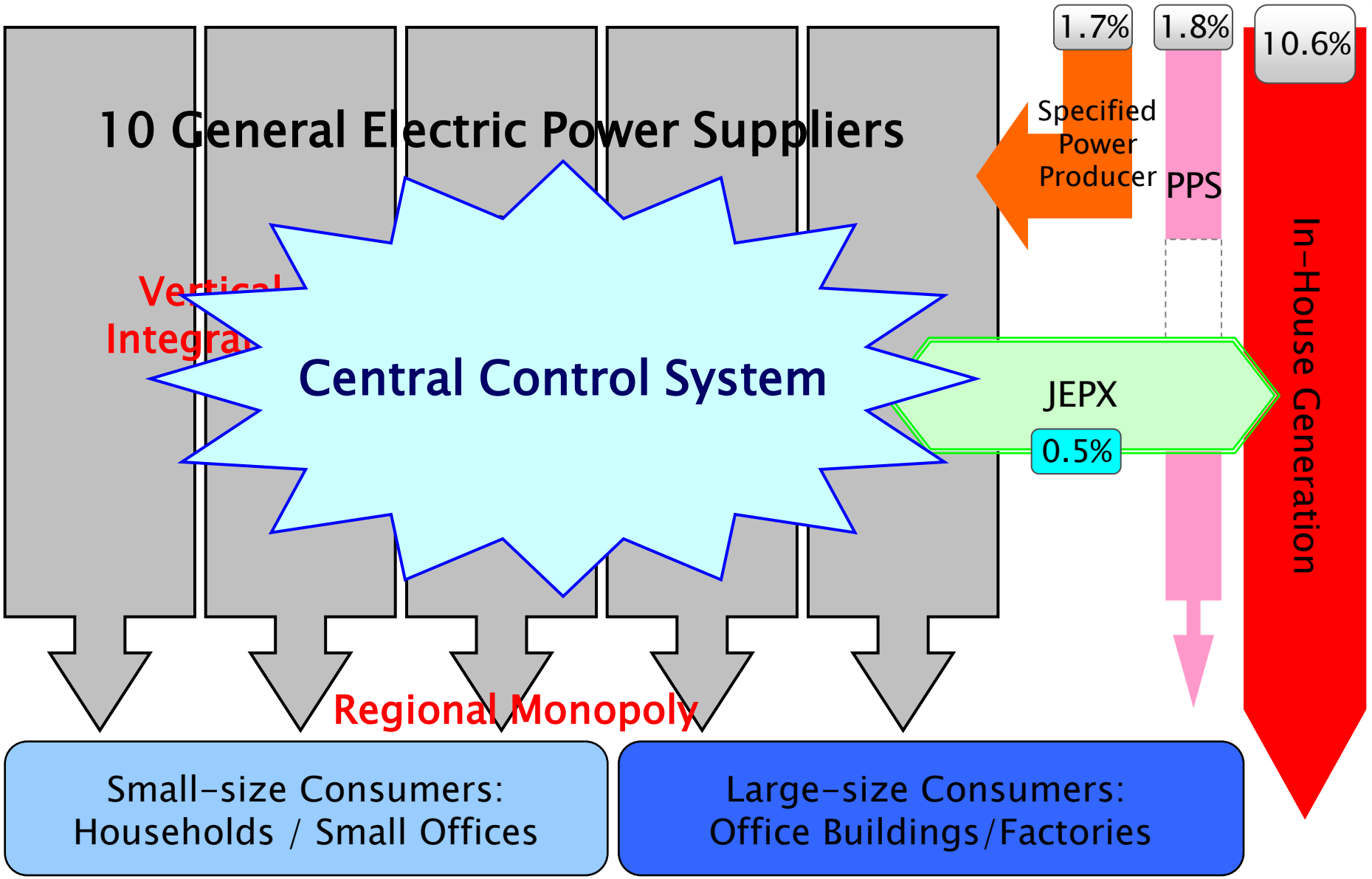
Japan's Existing Power System



Nature of Central Control System

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Economy of Scale

Dependence on Centralized Power Sources

- large-scale generation : Nukes
- advantage of larger incumbents

Economy of Scope

Vertical Integration

- generate, transmit & distribute, retail
- stable supply : shorter blackout time
- balancing demand & supply by utility

Natural Monopoly

Planned Economy/Closed Market

- approved tariff : no skyrocketing
- limited choices for consumers

High Tariff, but Stable Supply

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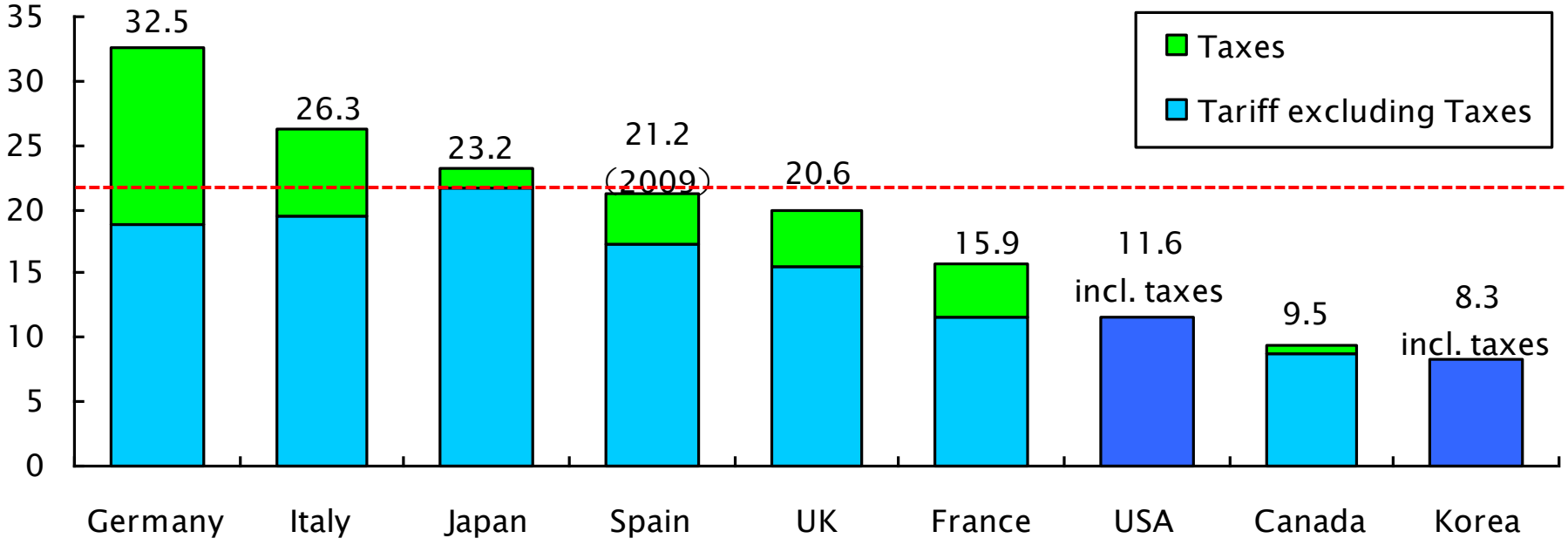
– Electricity Tariff by Country in 2010 –



Source: IEA, Energy Prices & Taxes 2011

– Annual Blackout Time per Household –

Country	Japan	Korea	Germany	Italy	France	UK	USA
Minutes	16.0	17.2	19.3	58.0	61.6	75.7	292

Source: METI

Nature of Decentralized-Autonomous System

Reliance on Decentralized Power Sources

- small-size gas turbines
- cogeneration/in-house generation
- renewables : wind, PV, biomass, geo thermal

Market Liberalization

- open competition in generation and retail
- varying prices : demand response
- more choices for consumers

Unbundling of Transmission Grid

- establishment of TSO
- balancing demand & supply through market
- system operation in wider area

Paradigm Shift

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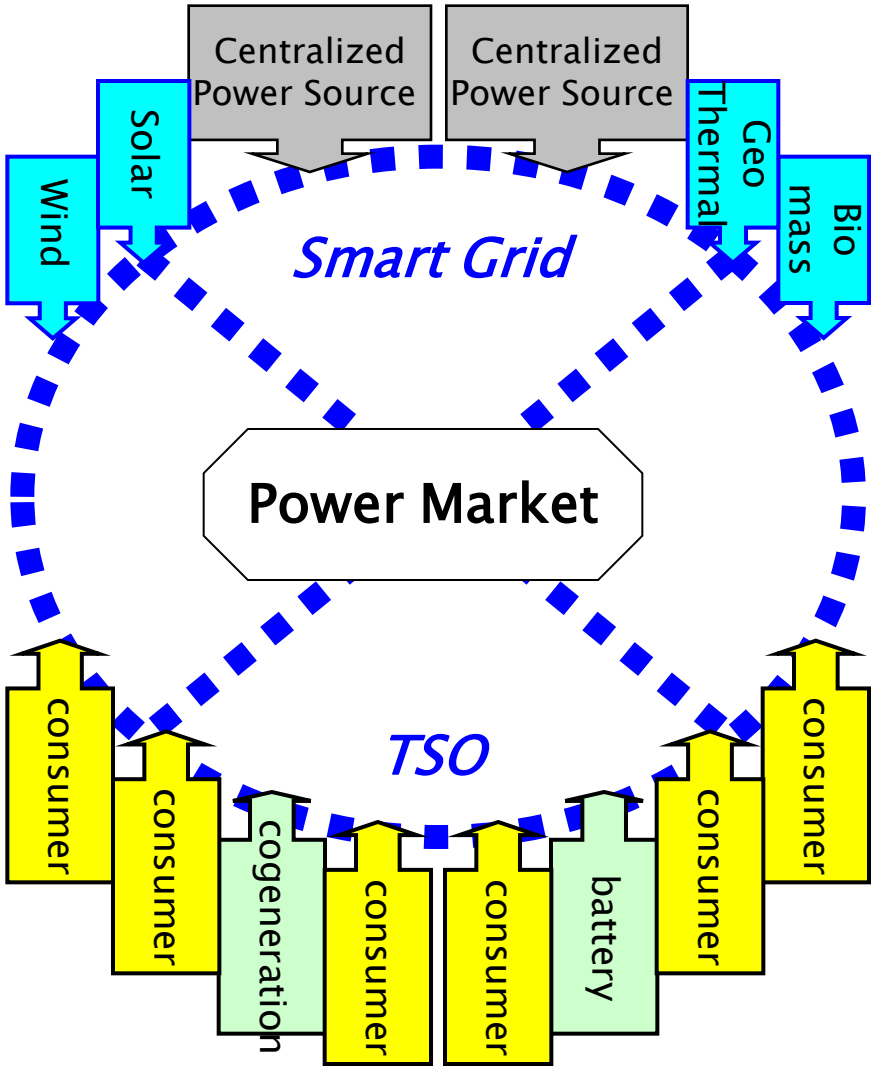
– Central Control System –

Large-scale
Centralized Power Sources

Long-distant
Transmission

Consumer Consumer Consumer Consumer

– Decentralized-Autonomous System –



Motivation for Smart Grid

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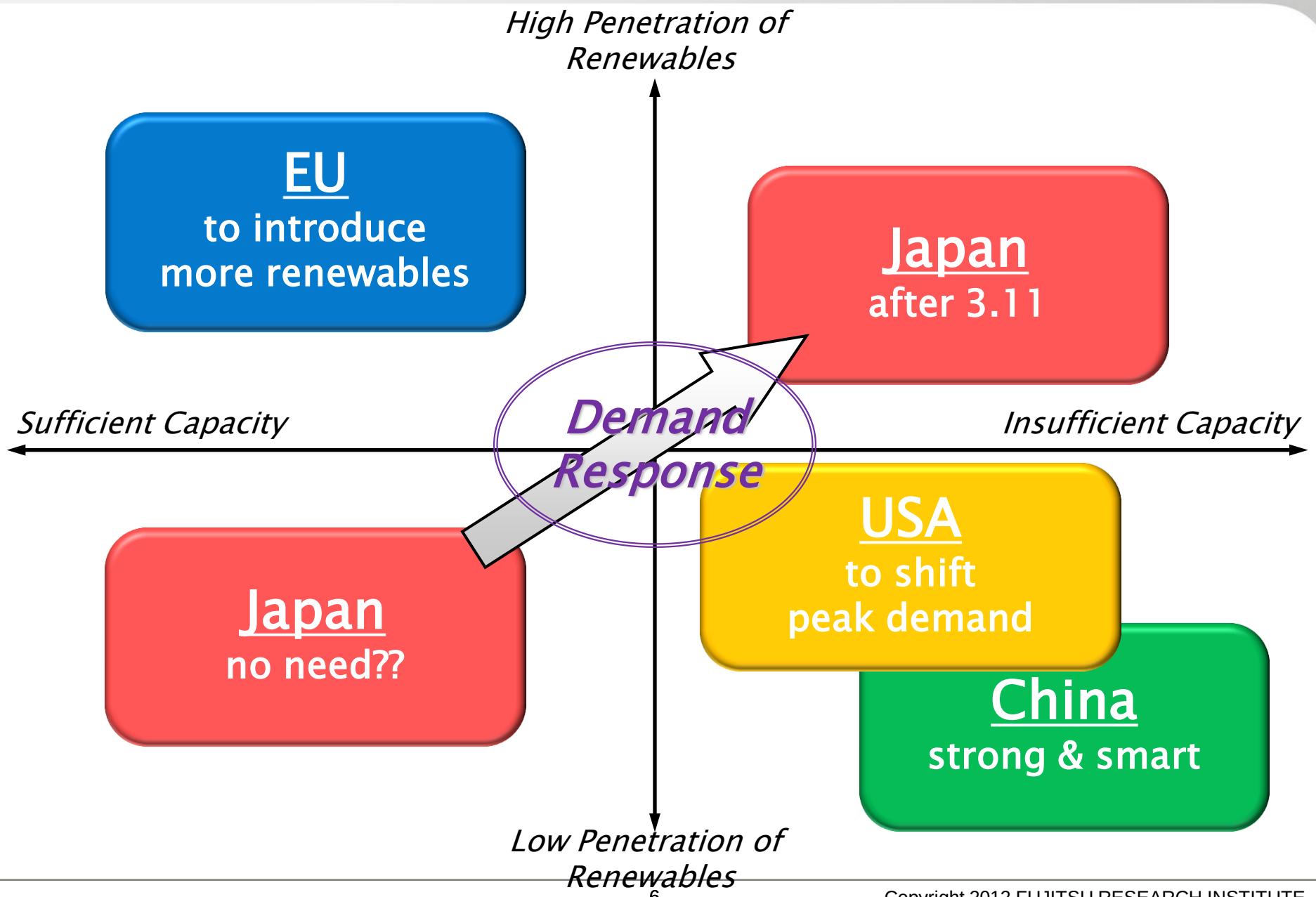

Demand Response after 3.11

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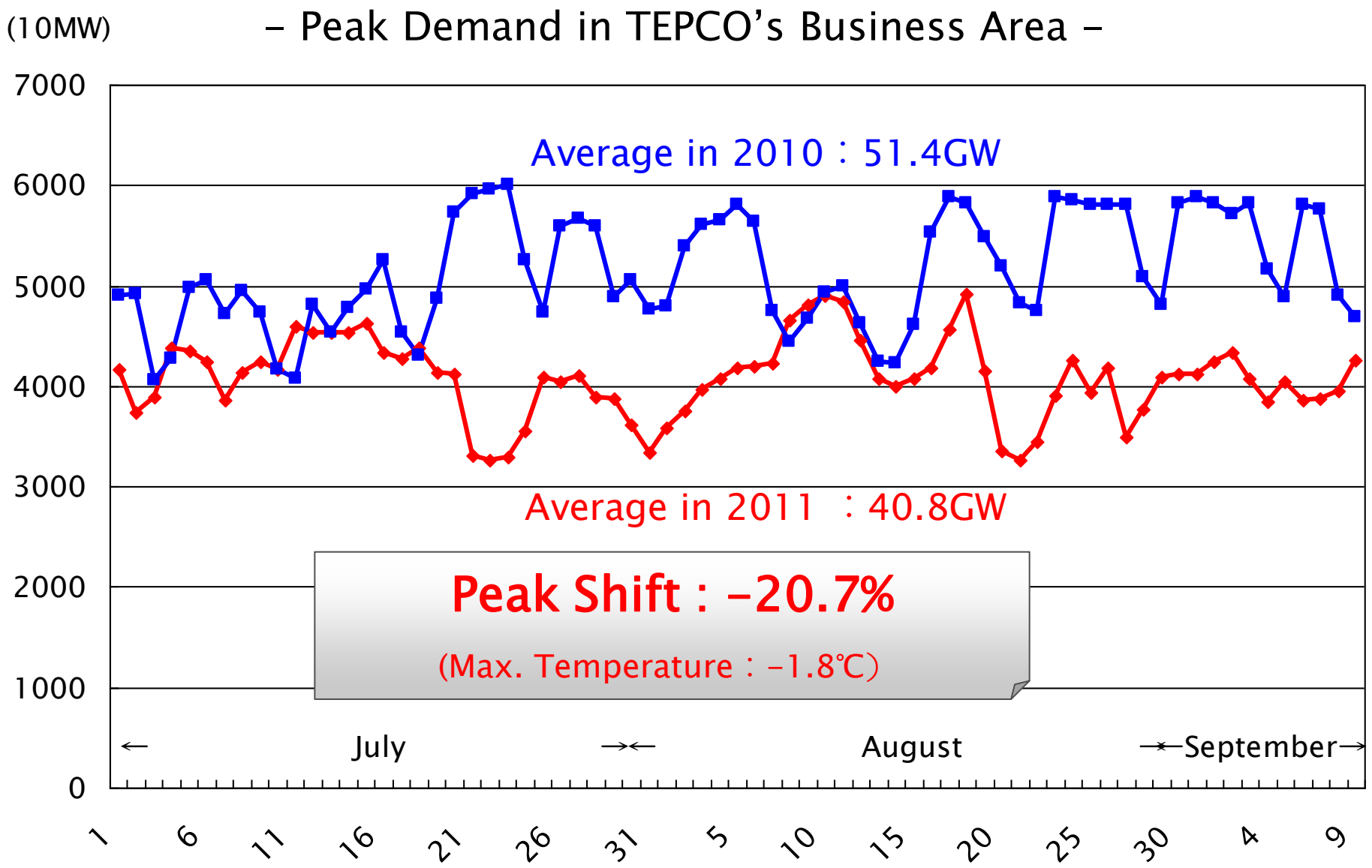

Source：TEPCO's website

Japan's Potential toward Decentralized-Autonomous System

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Renewables

× Low Penetration

resources

feed-in-tariff

industry

technology

High Penetration?

Transmission Network

× Bundled

50Hz/60Hz

private-owned utilities

Asia Super Grid

Unbundled?

Political Leadership

Power Market

× de facto Mono

Competition?

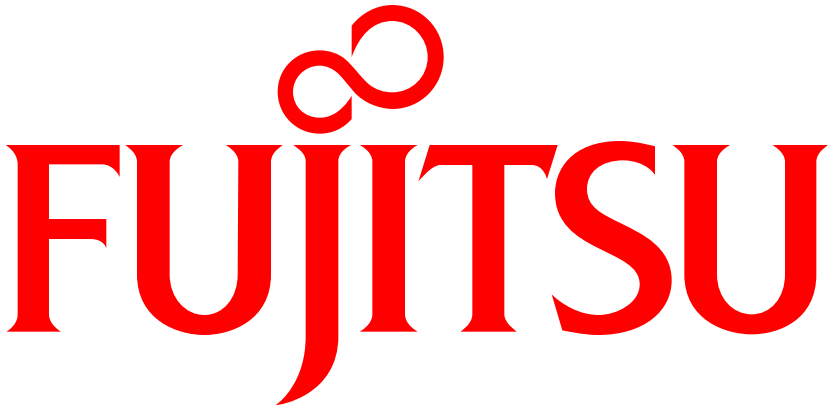
Smart Grid

△ just Started

consumers' consciousness

IT/battery

Realized soon?



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More “Services” in Power System

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– Central Control System –

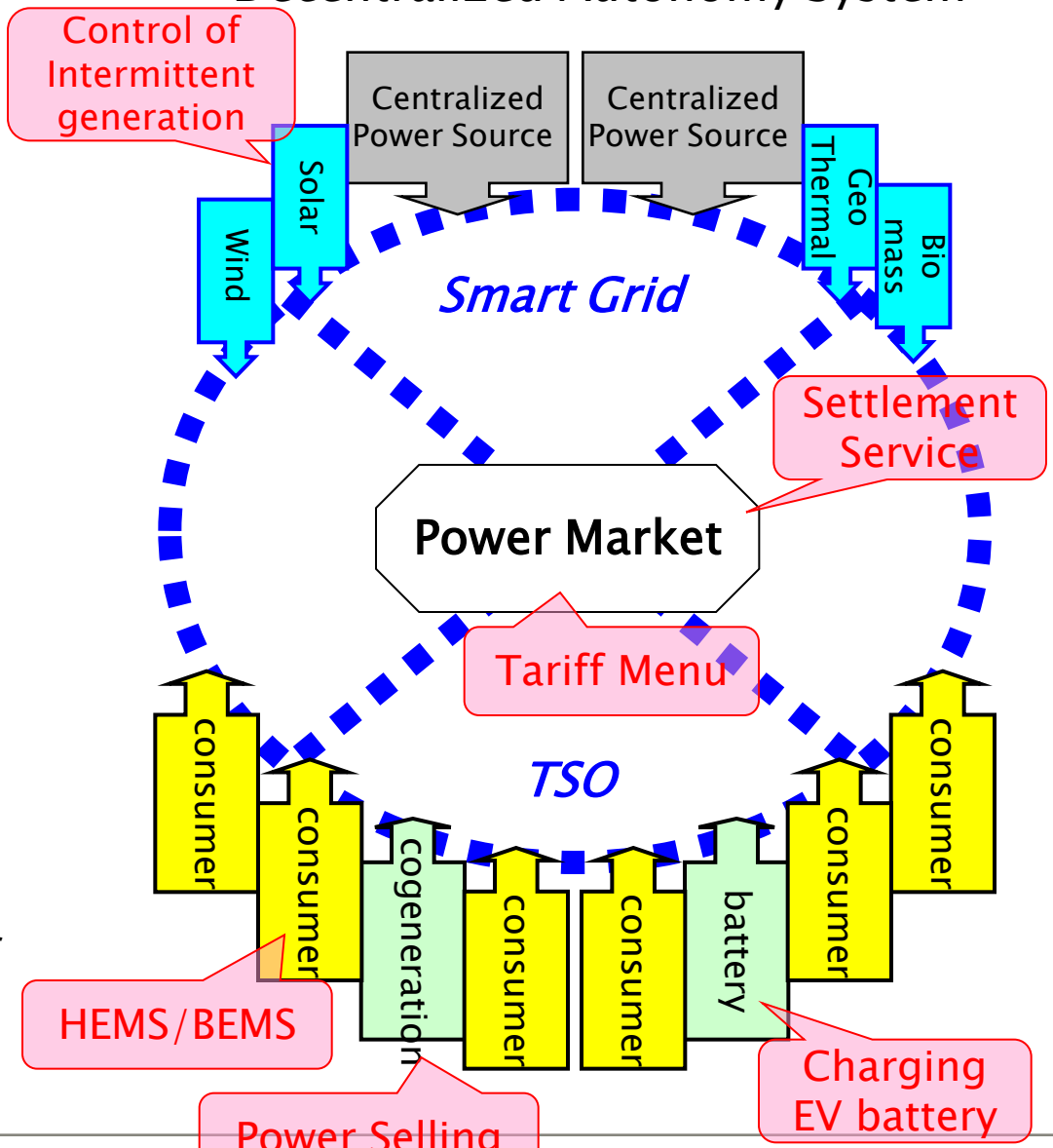
Large-scale
Centralized Power Sources

Long-distant Transmission
to Urban Cities

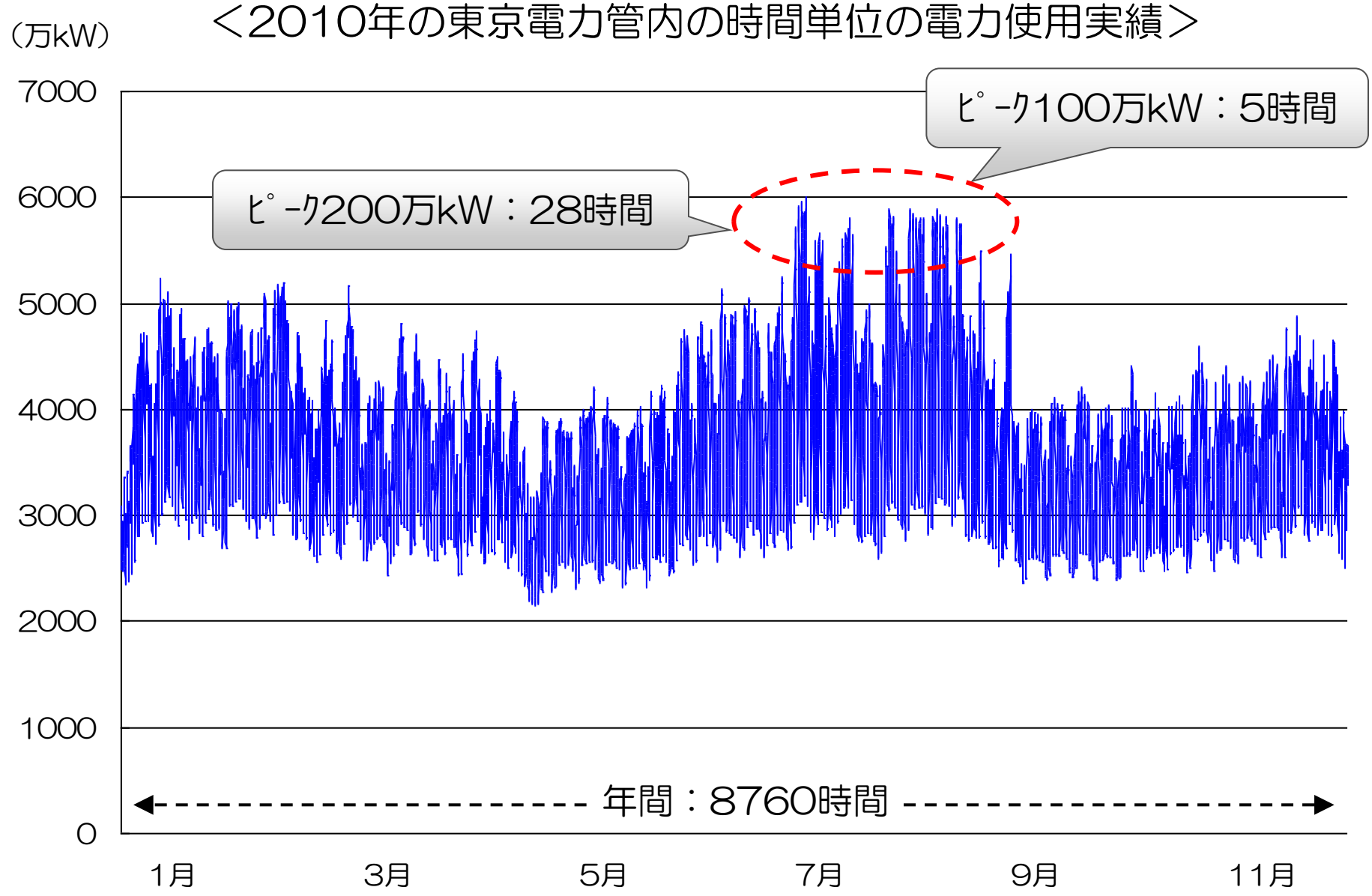
“Service” = supplying electricity as it is

Consumer Consumer Consumer

– Decentralized Autonomy System –



ピークシフト・ピークカットの重要性



出典：東京電力ウェブサイトを基に筆者作成

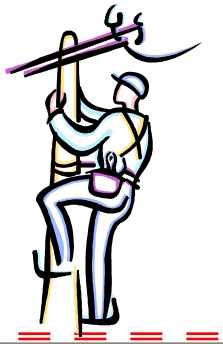
Analogy of Internet

通信と電力を題材に・・・

Central Cot

- 旧来の固定電話

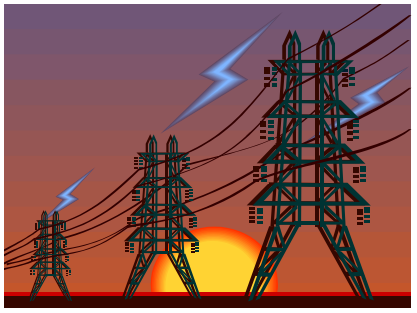
- 既存の電力網



自律分散システム

- インターネット

- スマートグリッド



IT革命：情報通信におけるイノベーション

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インターネットのアナロジー

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コンピュータ産業

＜メインフレームの時代＞

IBM　NCR　富士通　日本電気

＜パソコンの時代＞

- OS：マイクロソフト
- CPU：インテル
- 組立：台湾メーカー
- 設計販売：デル

水平分業化

サービス化

電気通信分野

＜電話の時代＞

電電公社　国際電電　AT&T　BT

＜インターネットの時代＞

- ｻｰﾋﾞｽ･ｱﾌﾟﾘｹｰｼｮﾝ：無数
- 端末：多数
- ルーター：シスコ
- キャリア：NTT

電気事業の水平分業化

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＜電力網の時代＞

＝発送電一貫

安定供給義務

東京電力 | 関西電力 | P G & E | E.ON

受動的な電力消費者

＜スマートグリッドの時代＞

＝発送電分離

発電会社：多数

送電会社：独占

AMI：複数

小売り・サービス：多数

自律的な電力消費者

JX日鉱日石エネルギー

Energy for Tomorrow 日本風力開発株式会社 JAPAN WIND DEVELOPMENT CO.,LTD

EDF

nationalgrid THE POWER OF ACTION

SILVERSPRING NETWORKS

Google

Renewables: Obstacles to Diffuse

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	Reactions by Other Countries	Japan
1. High Cost of Generation	– Feed-in Tariff	△ (2012)
	– Subsidies	△
2. Regulation/Local Opposition on Location	– Regulatory Reform	×
	– Simpler Transaction	×
	– Government's Intermediation	×
3. Discretional Refusal of Grid Connection	– Grid Unbundling	×
	– Priority Access of RE (FIT)	△ (2012)
4. Grid Instability due to Intermittent Generation	– Wide-area Grid Operation	×
	– Pumped Storage Hydro	△ (only for Nukes)
	– Smart Grid/Demand Response	△
	– Battery/EV	△

Regional Monopoly

Vertical Integration

Potential Resources of Renewables

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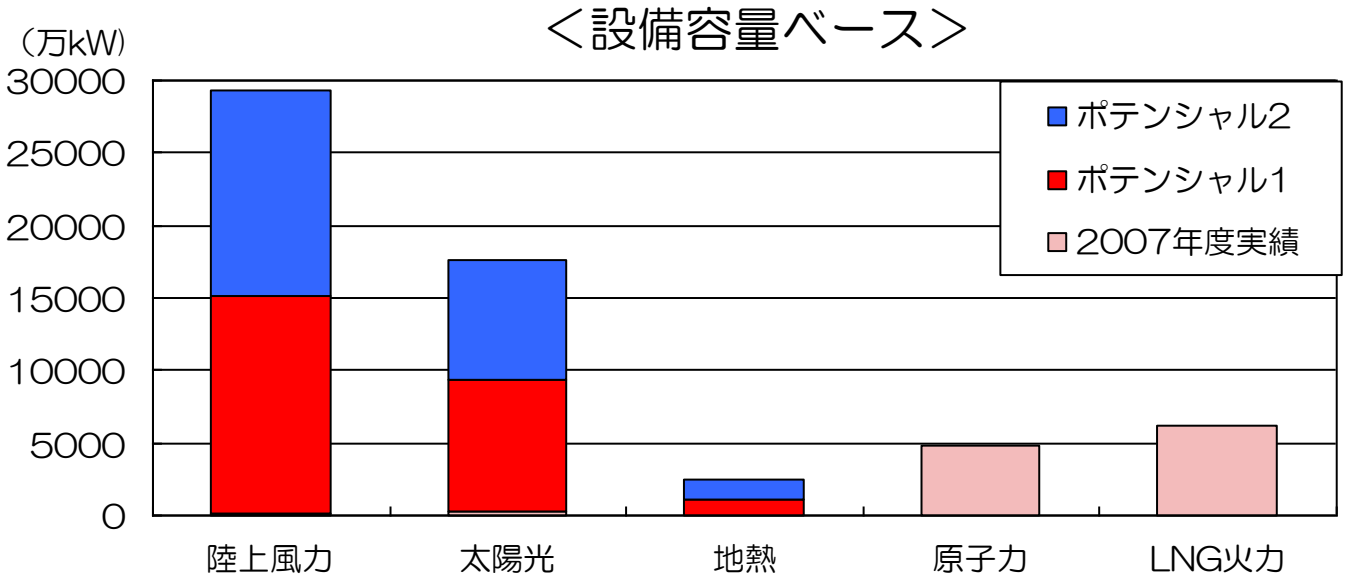

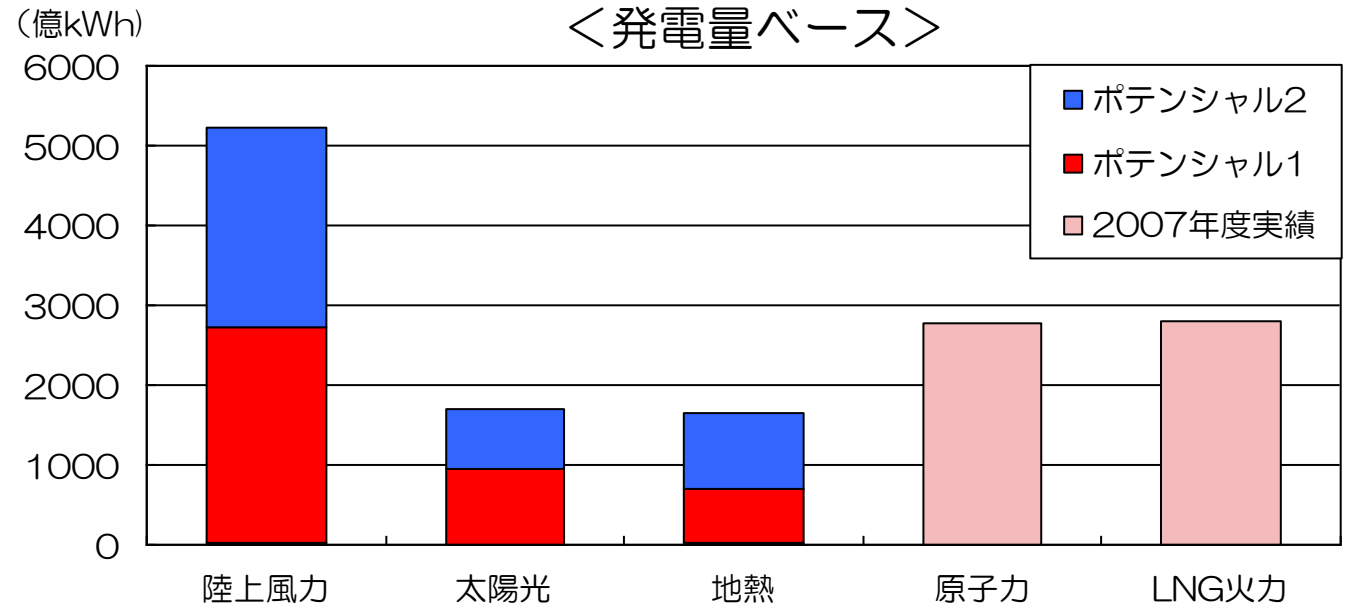

※導入ポテンシャル：
自然要因、法規制等の開発不可地を除いて算出したエネルギー量

※陸上風力：
１：保有林外、国有林外、自然公園外
２：国有林内、自然公園内

※太陽光：
１：戸建住宅屋根、ﾏﾝｼｮﾝ屋根、公共施設・工場等大きな屋根
２：工場等中規模屋根や壁面、ﾏﾝｼｮﾝ壁面、高速道路の南壁面

※地熱：
１：150℃以上の熱水資源、特別保護地区・特別地域への傾斜掘削を含む
２：53℃以上の熱水資源、特別保護地区・特別地域への傾斜掘削を含む

Source: Report of Verification Committee for Generation Cost

Generation Cost by Power Sources

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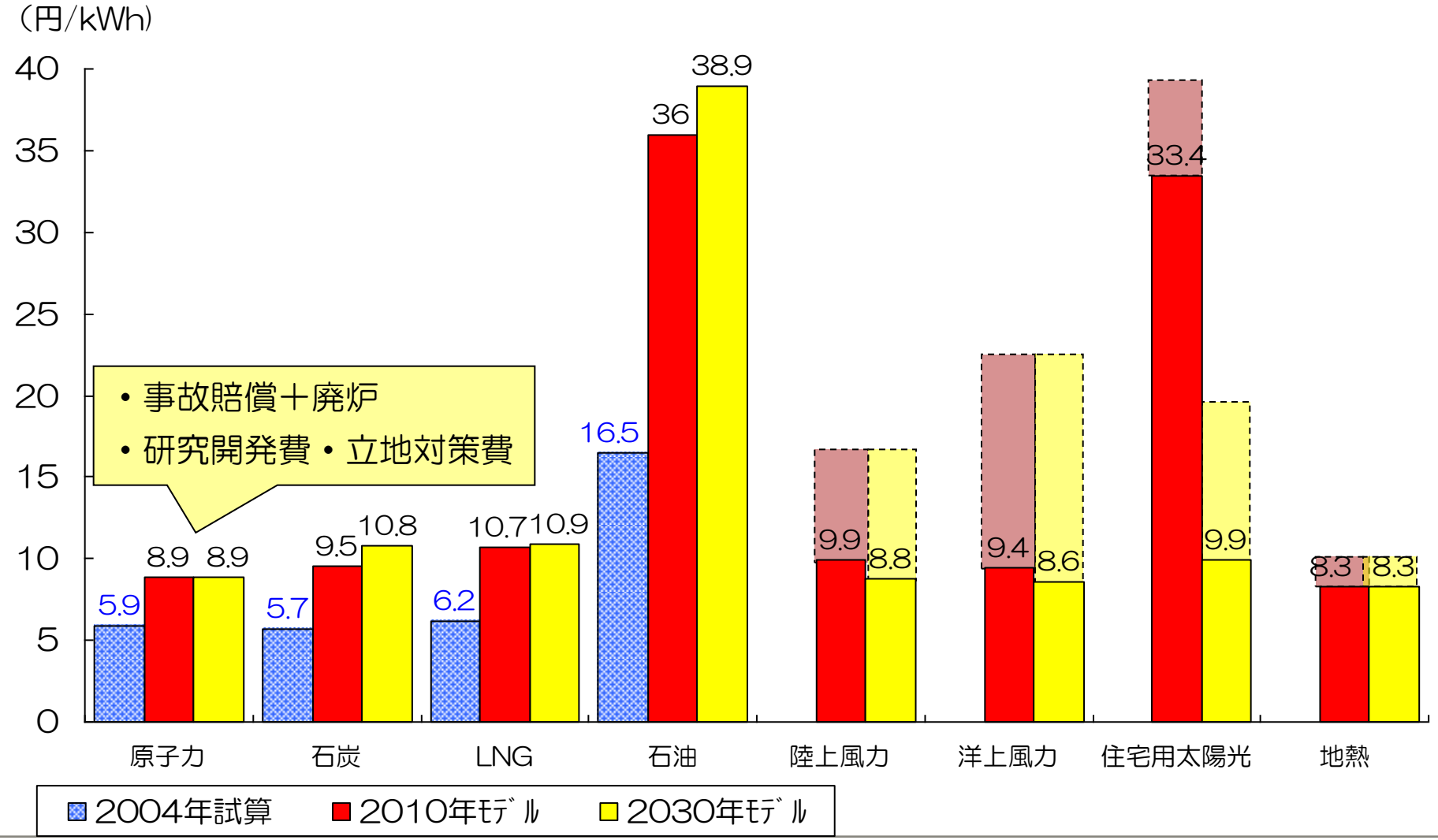
＜電源別の発電コスト＞

- 以前：資本費＋運維持転費＋燃料費
- 今回：＋CO2対策費＋事故対応費＋政策経費



Source: Report of Verification Committee for Generation Cost

Limited Inter-regional Grid

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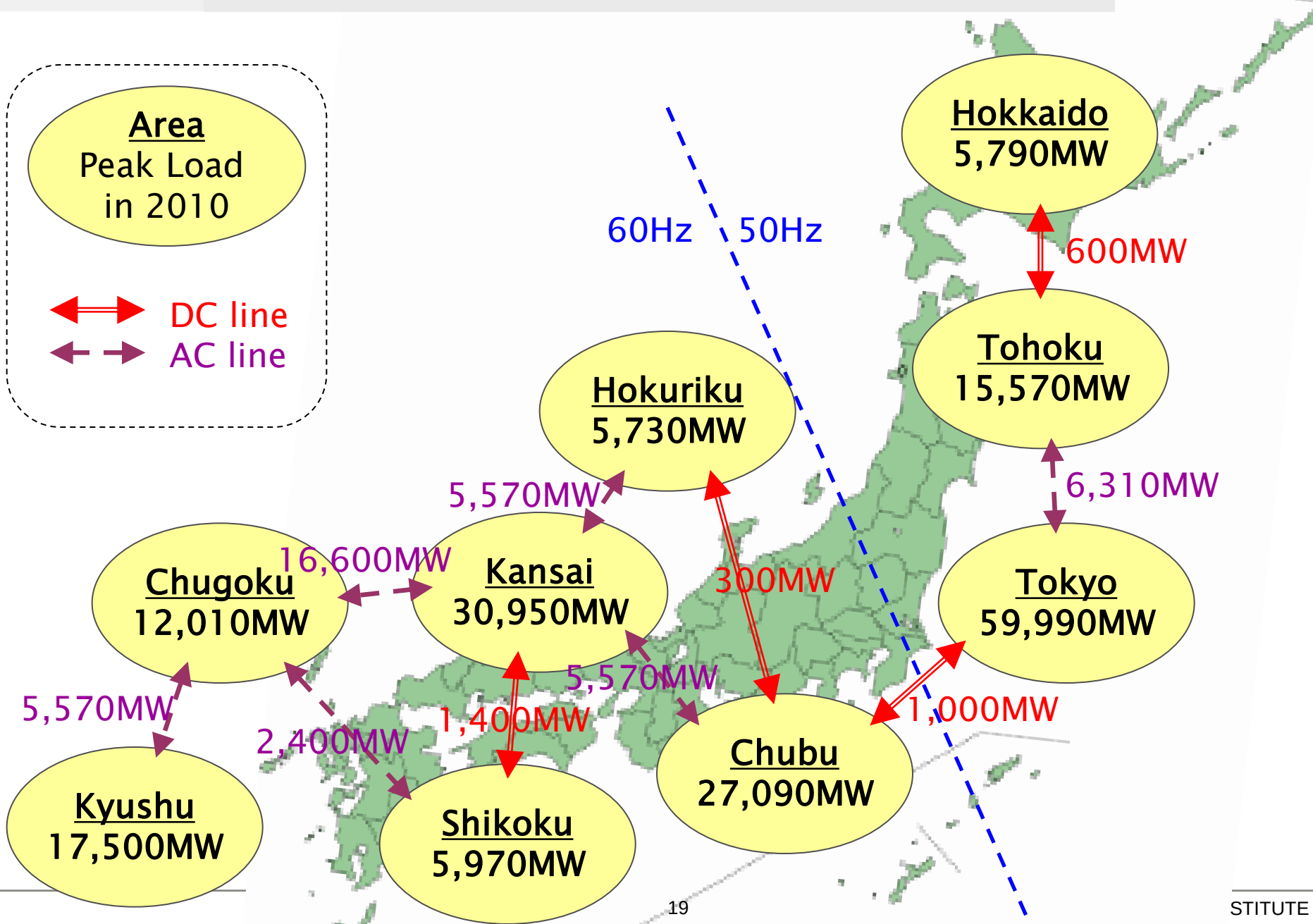

Grid Access by "Lottery"

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– Capacity of Grid Access for Wind Power allowed by Utilities –

	Access Capacity (October, 2010)	Ratio among Total Generation Capacity
Hokkaido Electric	360MW	6.36%
Tohoku Electric	1180MW	7.76%
Hokuriku Electric	250MW	4.39%
Chugoku Electric	620MW	5.04%
Shikoku Electric	250MW	4.17%
Kyusyu Electric	1000MW	5.65%

Source: Federation of Electric Power Companies

Increasing Dependence on Nuclear

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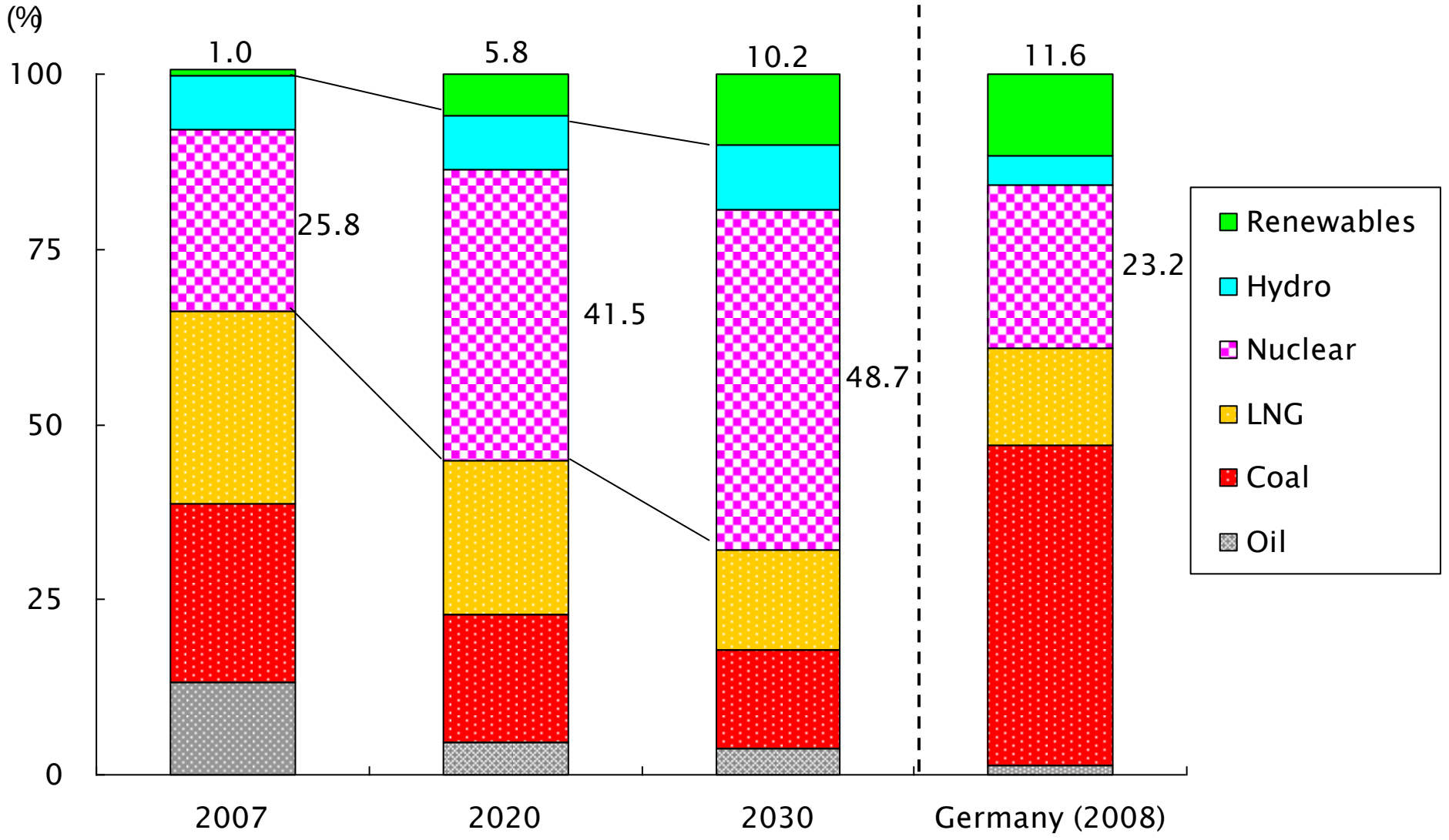
– Japan's Power Source Mix –



Source: METI for Japan, IEA for Germany

Policy Trend

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2012

November | January | March | May | July

Special Promotion Law for Renewable Energy

Tariff announcement — *Start of the FIT Scheme*

Regulatory Reform of Electric Utility

– *"Energy Basic Plan"* — *Draft* — *Cabinet decision*

TEPCO's management