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本邦洋上風力発電における自動車用駆動モータの再利用

Reuse of automotive drive motors
in offshore wind power generation in Japan

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AGENDA

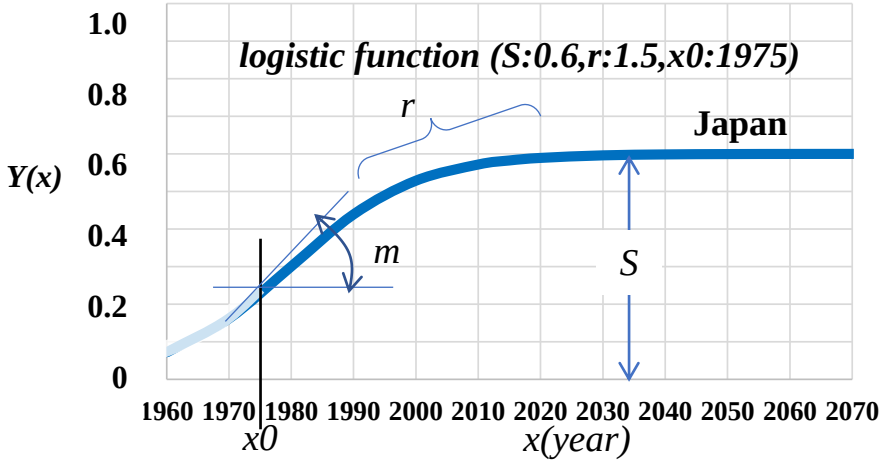
- ✓ First half — Supply and demand forecasts for automobiles through CY2100 based on population projections.
- ✓ Second half — Application of automotive drive motor systems to offshore wind power

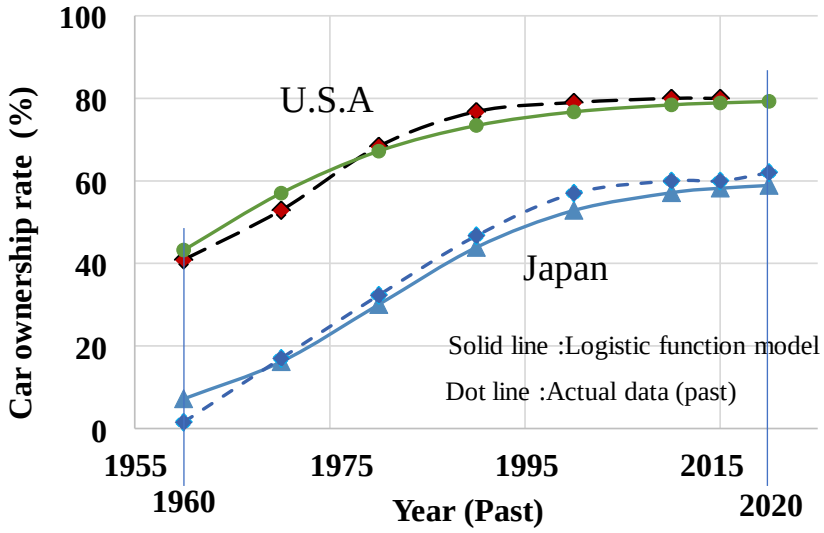
Calibration of logistic function to actual data from 1960 to 2020

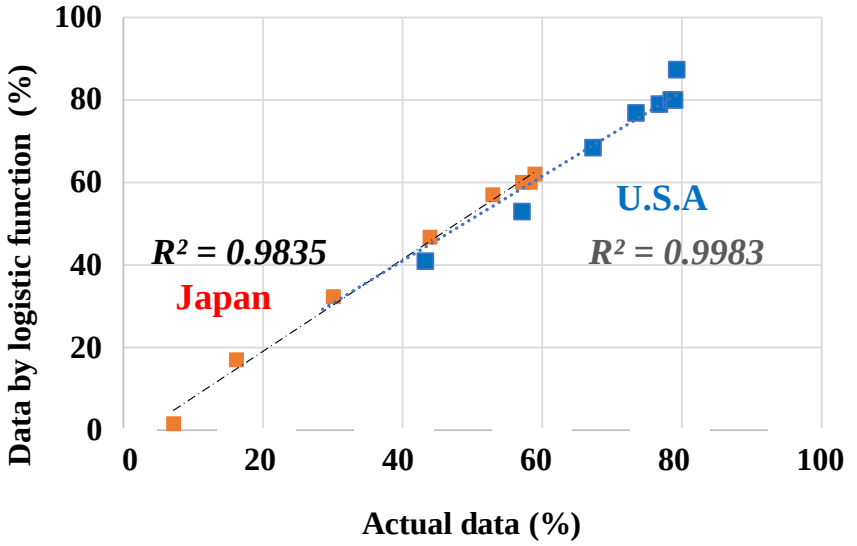
Car ownership rate(%) :
Number of private cars and commercial vehicles owned per 1,000 people

Logistic function: Y(x) = S/(1+m*EXP(-r*(x-x0)) (1)

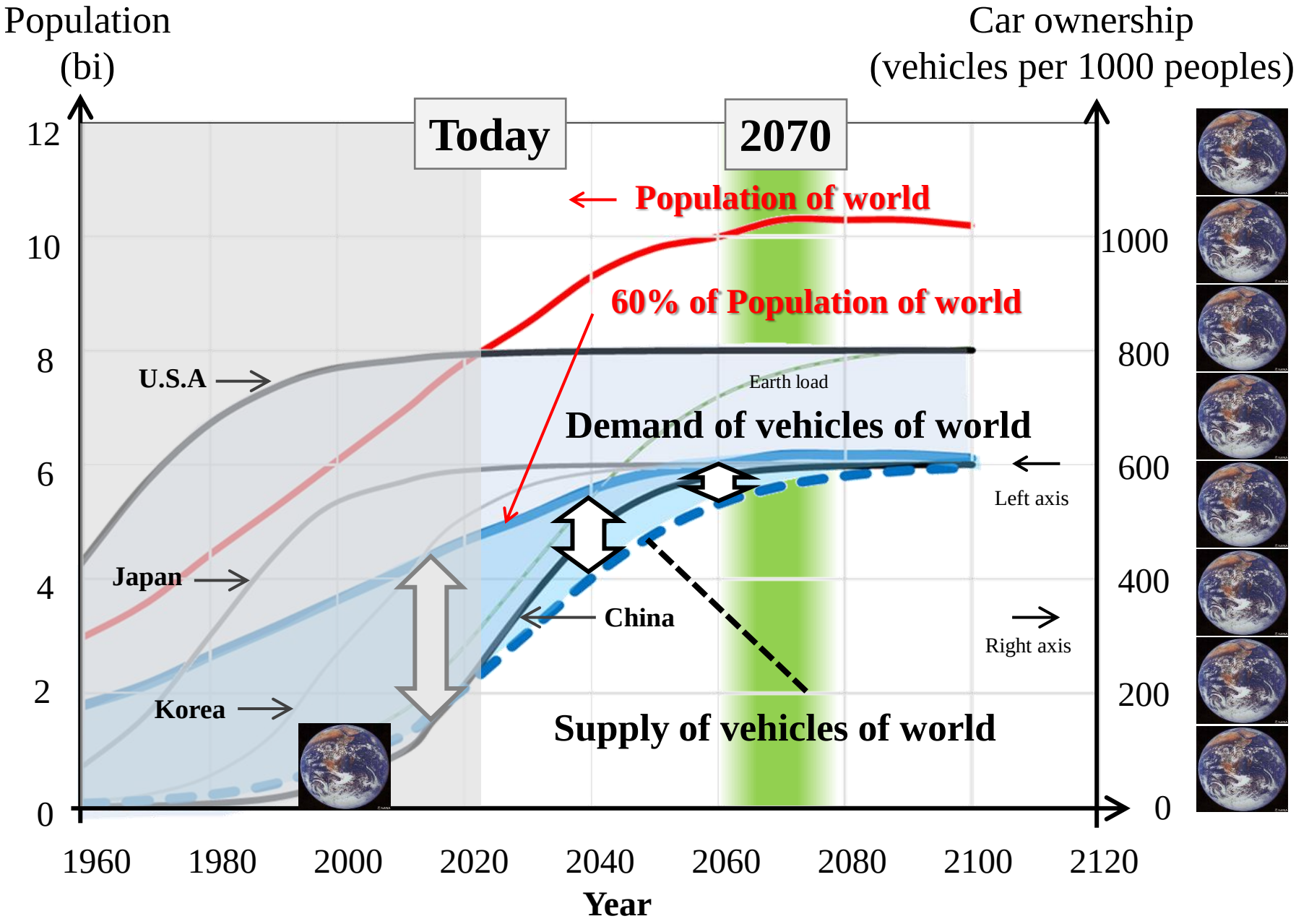
x : Percentage of car ownership in year x
$x0$: Initial year
S : Saturation coefficient
m : Initial coefficient
r : Growth coefficient







Saturated mobility demand seen from car ownership rate.



Japan's Energy Self-Sufficiency Rate and Energy balance

2023.1.14

Primary energy

Imported fossil energy is 90%

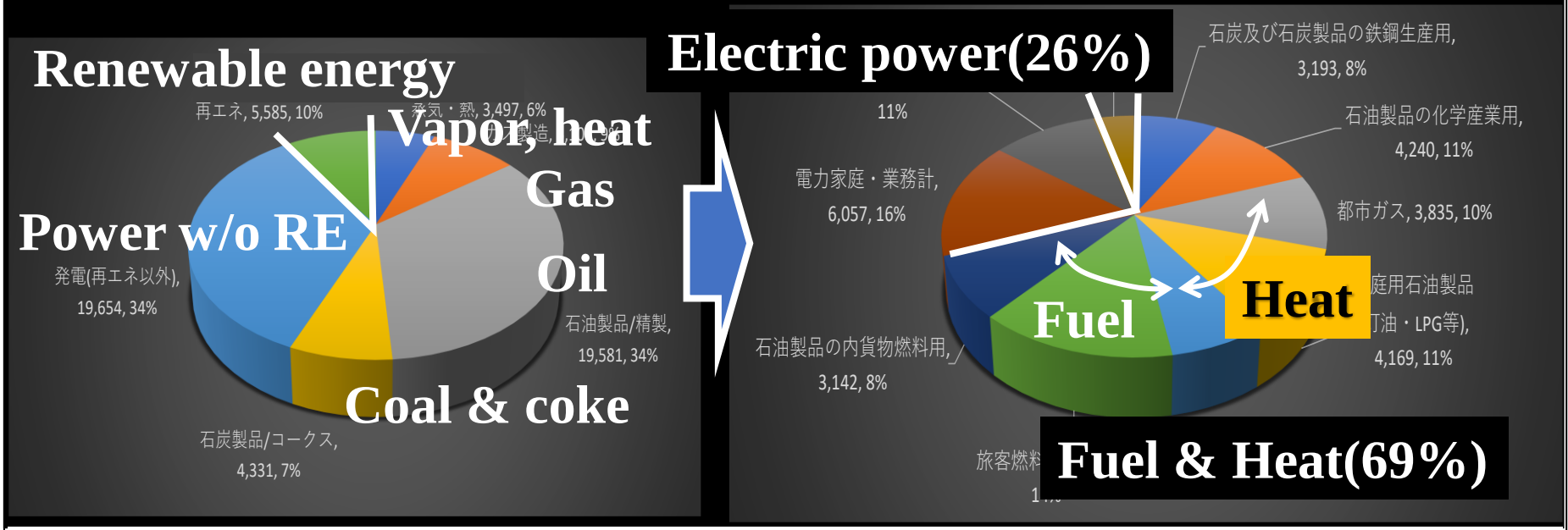
5.8 (TWh) / Year

Final energy consumption

Non-electric sector consumes 70%

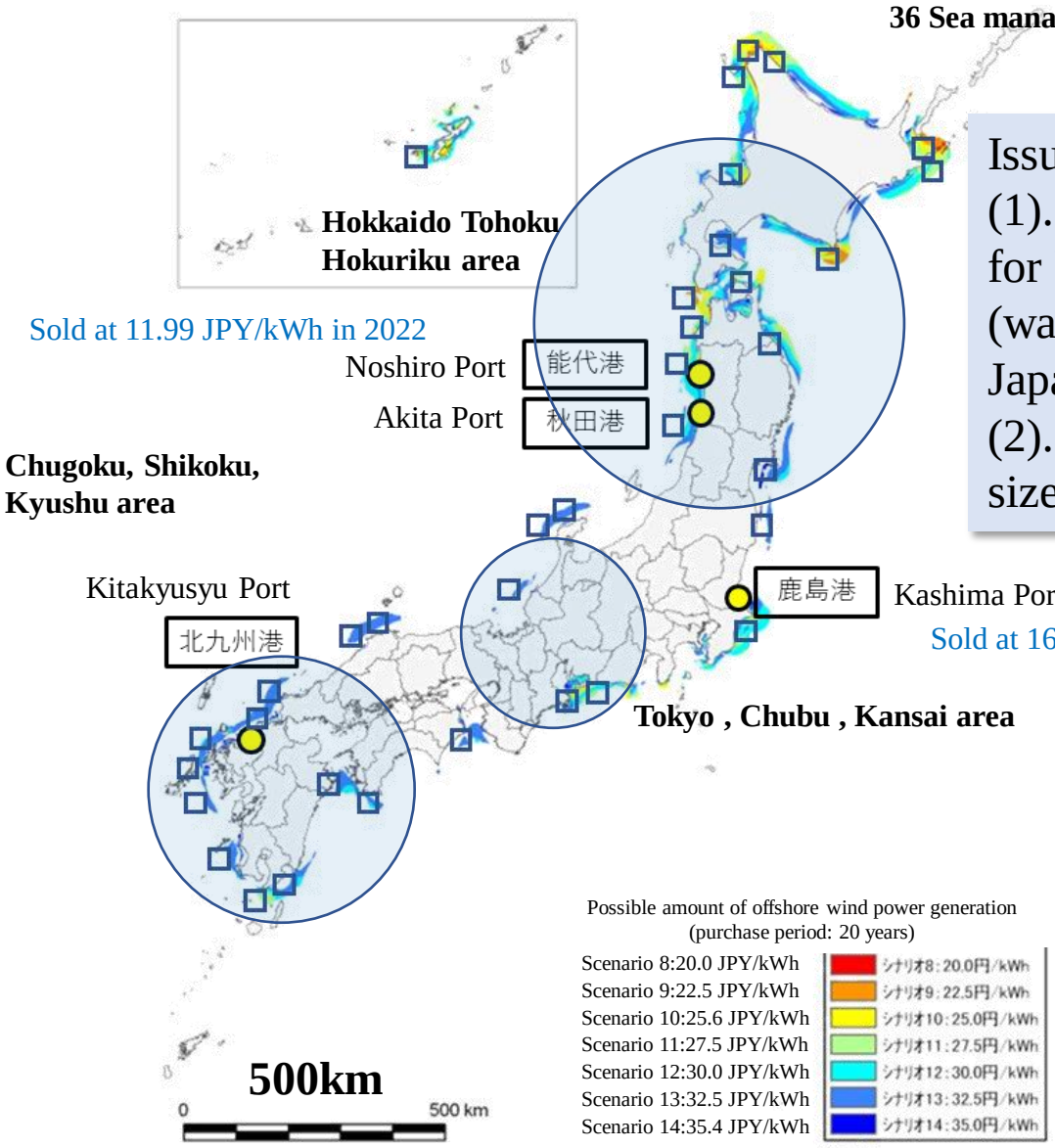
3.9 (TWh) / Year

Efficiency 66%(W2T)



Source: EDMC2019 Handbook of Energy and Economic Statistics, The Institute of Energy Economics, Japan, Energy Balance Table/METI., Author converted the units and made some edits to create the figure.

Sea areas with good wind conditions and port areas for installation of wind turbines but has issues.



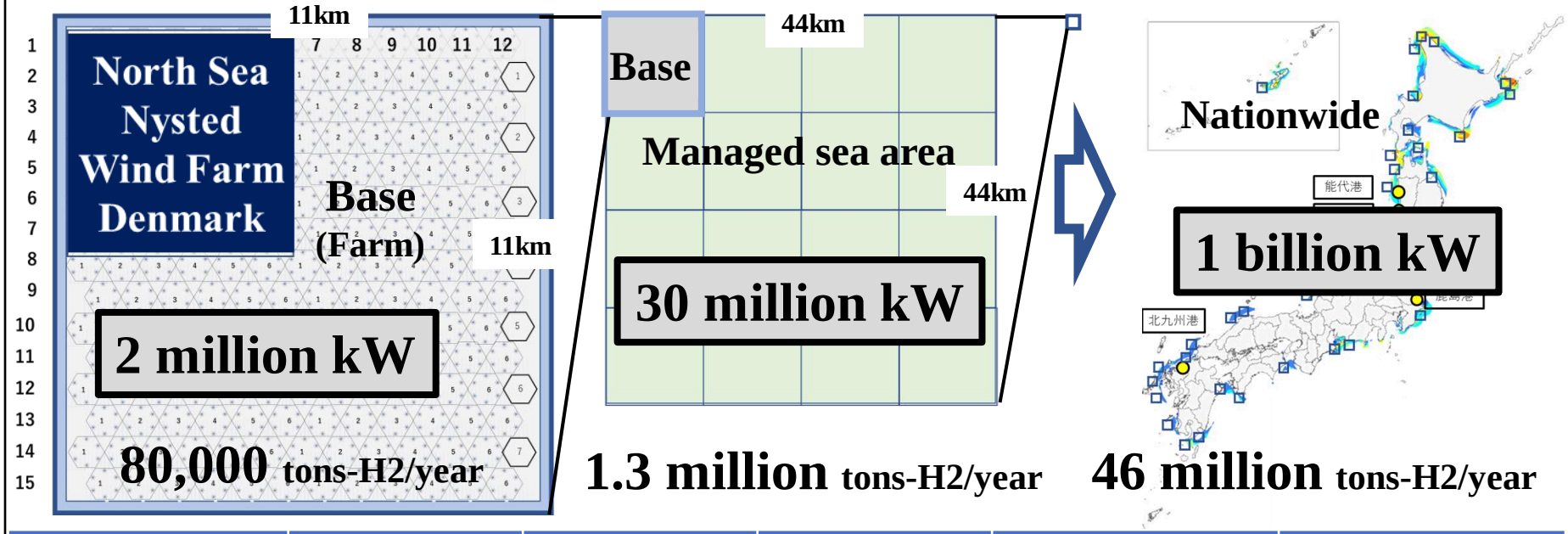
Issues.
(1). There is no experience in Europe for R&D of large floating wind turbines (water depth and typhoon intensity in Japanese waters).
(2). Longer payback period due to larger size

Possible amount of offshore wind power generation
(purchase period: 20 years)

- Scale of 36 managed sea areas, 44km square,70,000km^2
  Actual sea surface coverage is 0.1%, 70km^2 (8.3km square)

Source; MOE of Japan

Hierarchy and size for an electrolytic H2 supply capacity of offshore wind farms



	Unit	Operation site	Base (Farm)	Managed sea area	Nationwide
Operation site	-	1	180	2,880	103,680
Base	-	-	1	16	576
Managed sea area	-	-	-	1	36
Nationwide	-	-	-	-	1
Wind turbine	1	6	1,080	17,280	622,080
Motors	24	144	25920	414720	14,929,920
kW	1680:70kW*24	10,080	1,814,400	29,030,400	1,045,094,400
Tons-H2/year meets to nationwide demand			80,000	1,300,000	46,000,000

Increasing size of HAWT and FAWT

Reference plan

Displacement 22,500(t)

Rotor Dia 240m

400m

15MW

Tower

Floating structure

Floating system

Mooring lines

200m

Company A's plan

Displacement 12,000(t),w/o ballast

Blade Dia 185m
Height 180m

5~15MW

Generator

A380-800

Proposal B under study

Displacement 3,000(t),w/o ballast

Blade Dia 100m
Height 100m

1~3MW

360m

220m

Concrete ballast

12,000t

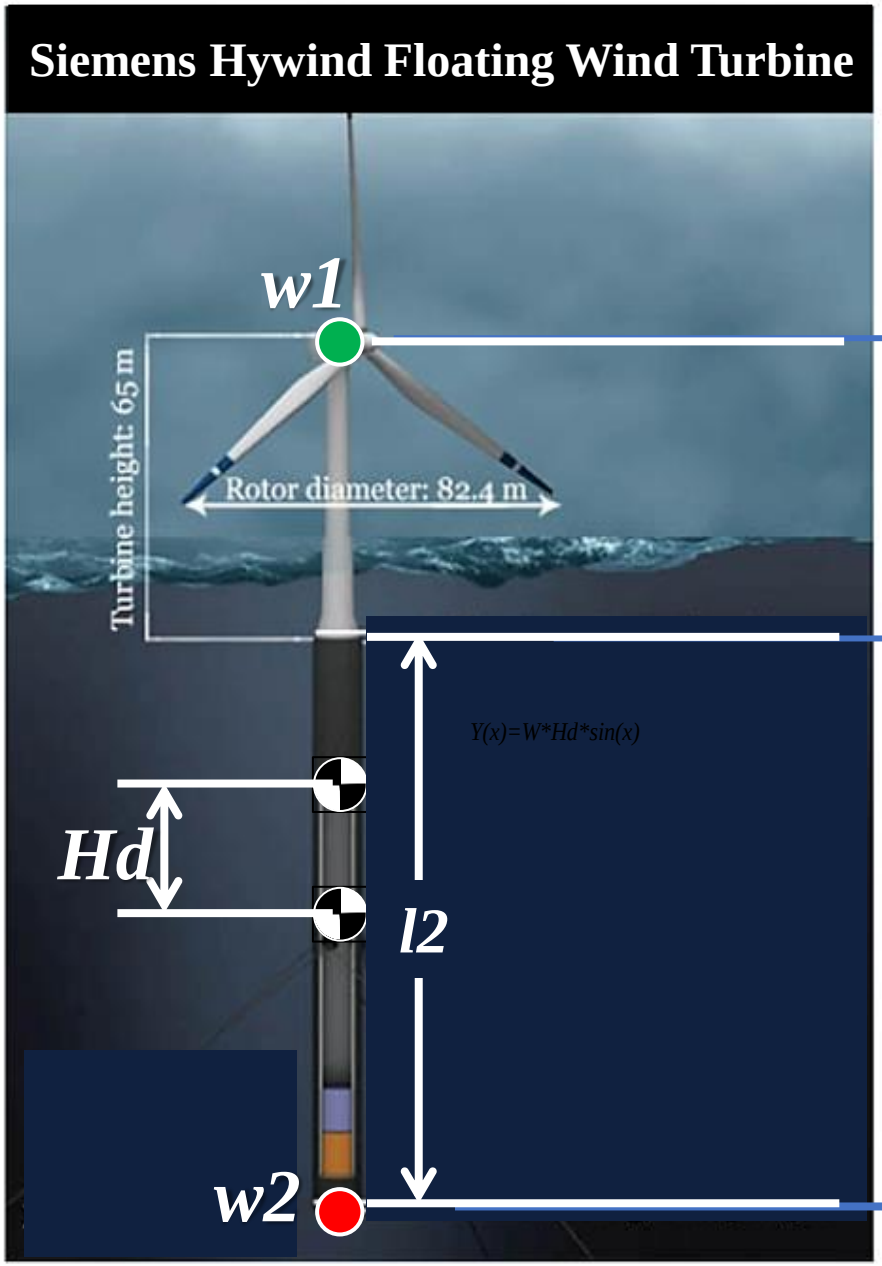
9,000t

Power line

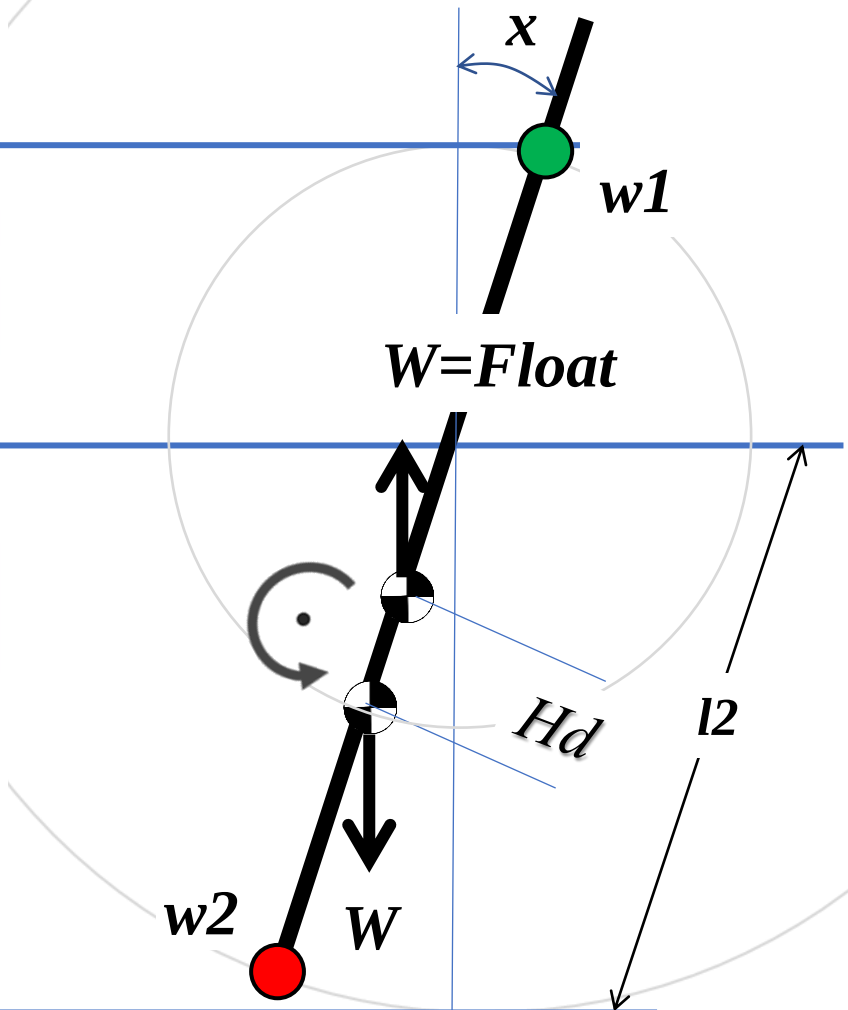
100m

Depth to seabed 100m～200m (~30km offshore)

First floating offshore wind turbine Hywind



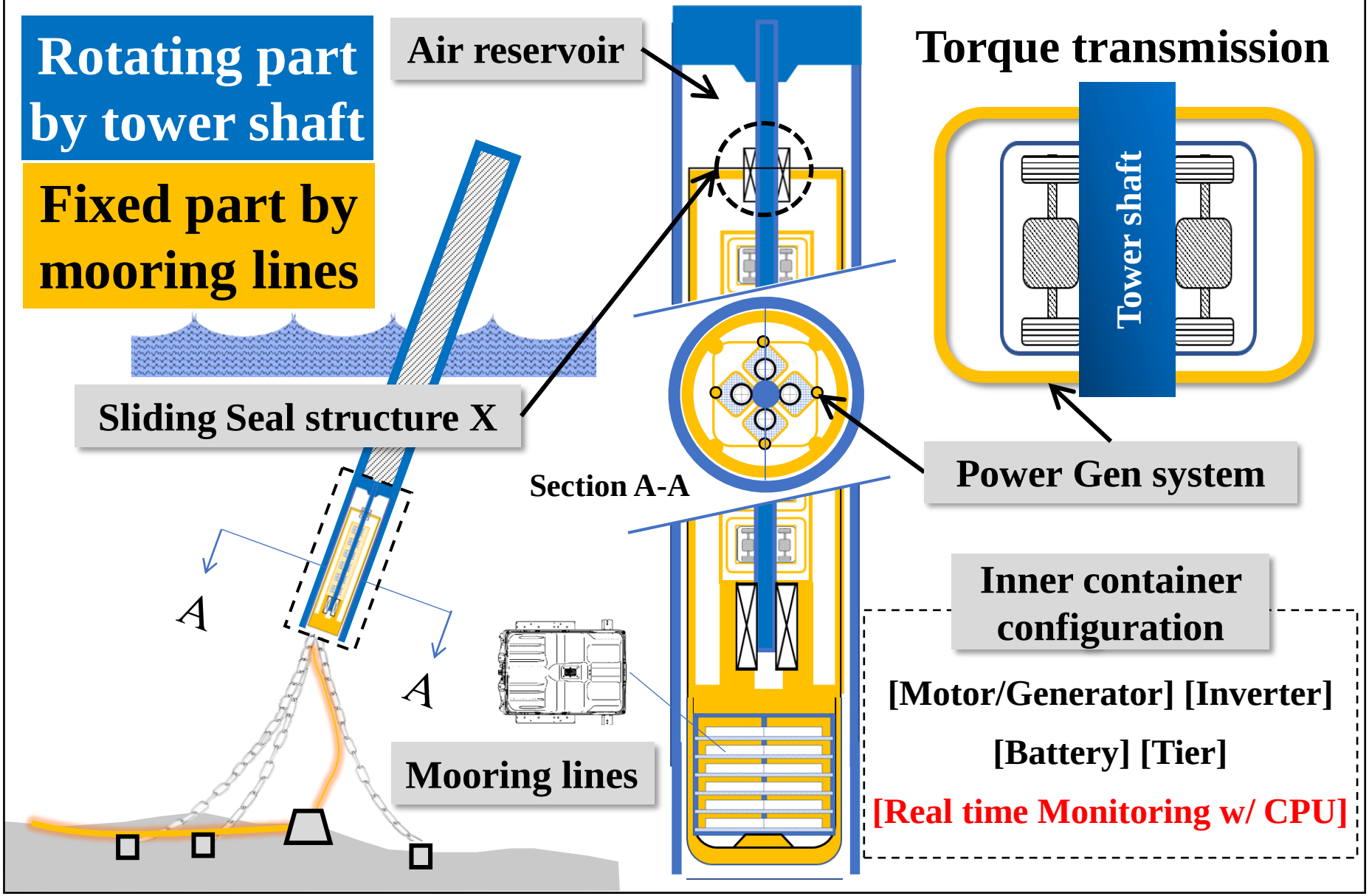
$$Y(x)=W*Hd*\sin(x)$$



Design concept study of Wind Turbine
-Torque Transmission & Power Generation System-

Rotating part by tower shaft

Fixed part by mooring lines



Discussion: Required amount of Hydrogen -Energy balance before/after-

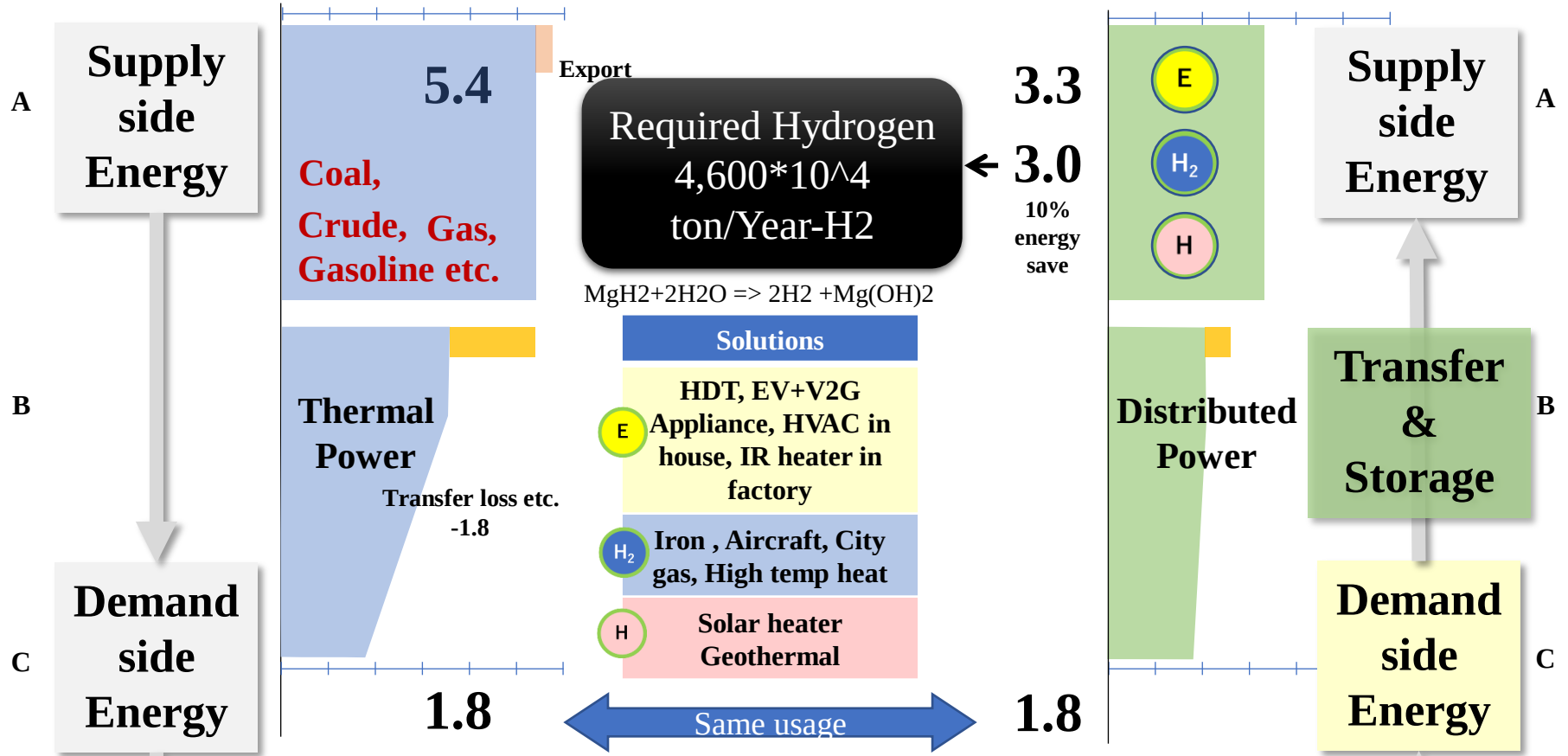
Before

91% Fossil Energy

[TWh/Year]

After

100% Green energy



Equivalent mean %, (TWh/Year)				
Efficiency	Before		After	
E (W2T): B/A	67%	5.4	64%	3.3
e (T2W):C/B	50%	3.6	86%	2.1
eE (W2W):C/A	33%	1.8	55%	1.8

E Replaceable Green Electricity

H2 Replaceable Green Hydrogen

H Replaceable Solar heat

Base source, Energy Data and Modeling Center(EDMC)::2017 energy balance summary table, Th energy conservation center , Japan (2019)

Conclusion

1. A logistic function ;The demand for goods in the world will be saturated around 2070.

2. The saturation amount and timing ;To develop appropriate technology development, and investment to eliminate the over and shorter estimation : Offshore wind power technology is a solution of simultaneous equation of issues that can/should contribute to automotive technology.

   (1) Climate change (CO_2 reduction, strengthening disaster prevention systems)
   (2) Energy security (shortening transportation routes through local production for local consumption)
   (3) Fossil fuel purchase cost saving (10 trillion yen/year)
   (4) Regional economic circulation through integration with port development, etc.
   (5) Mutual complementation of existing industries that are difficult to electrify (steelmaking, chemicals, boilers, etc.)

3. Numerous reused EV/HEV/PHEV motors can be installed in lightweight, low-cost floating wind turbines before 2030.

4. This report quantifies the energy supply-demand relationship in Japan, demonstrates the potential for energy independence through electrification and indirect hydrogen electrification, then discusses the following issues for reducing the electricity load.

   (1) Hydrogen distribution between transportation and industrial sectors
   (2) Development of technology to use water as hydrogen-containing fuel

Thank you for your attention

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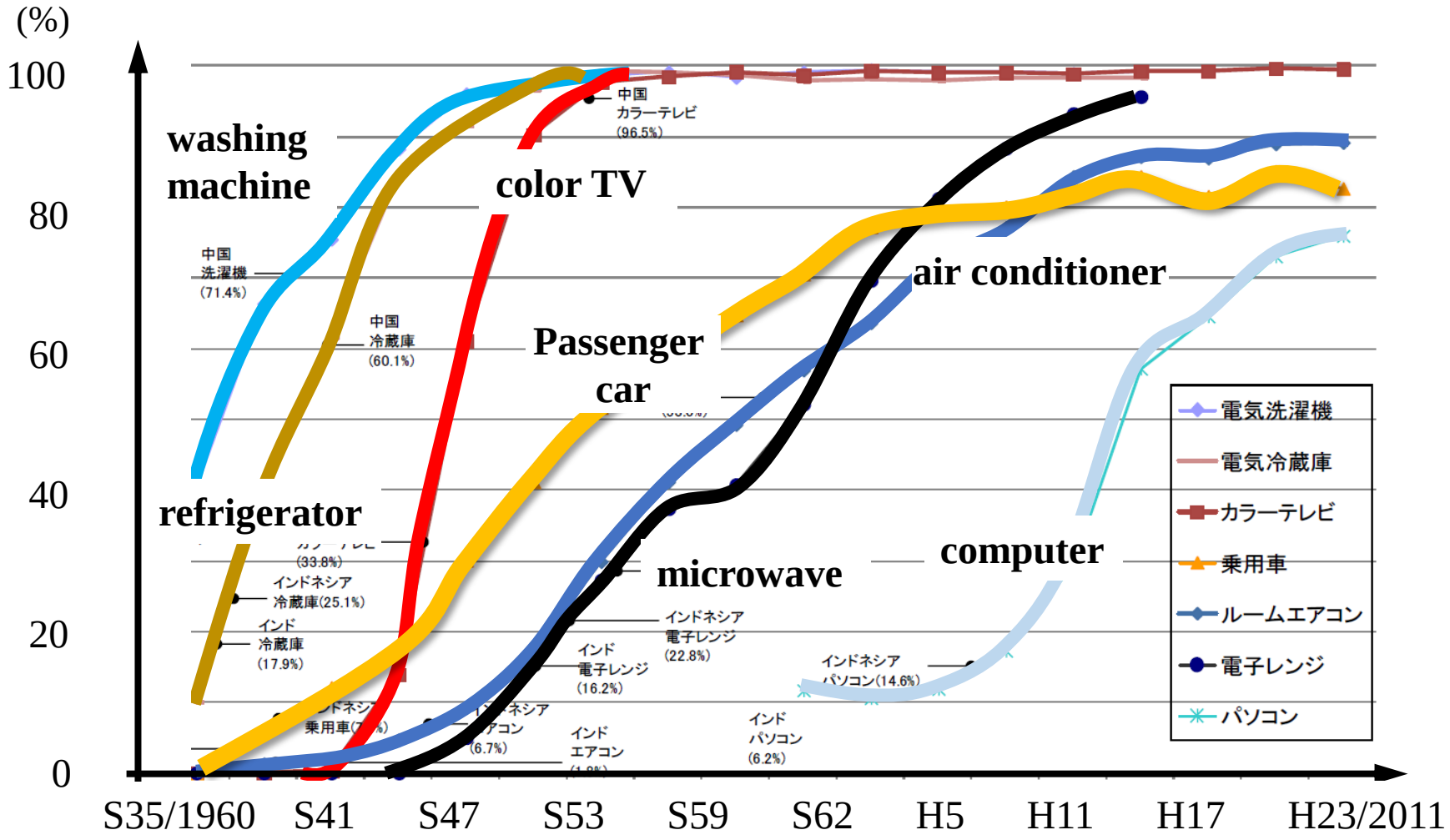
Conclusion

1.ロジスティック関数を用い世界のモノの需要を予測し,2070年頃に飽和することを示した.
2. その結果,次項に示す複層する課題に対し飽和量と次期に即して過剰/過少を排した適切な技術開発・投資・金融制度の準備ができる
3.複層する課題は以下であり 洋上風力発電発電技術は自動車技術としても貢献できる/貢献すべき連立解となる課題である.
①気候変動(CO２削減、防災体制強靭化)
②エネルギー安全保障(地産地消による輸送路短縮化)
③化石燃料購入費節約(10兆円/年規模)
④港湾整備等との融合による地域内経済循環
⑤電化の難しい(製鉄・化学・ボイラー等)既存産業の脱炭素化相互補完
4.具体例として,2030年を待たずして 大量の電動自動車が寿命を終え始めるのその再利用概念として軽量低コストを狙う浮体型風車への電動車モータの搭載検討例を紹介した.
5.我が国のエネルギー需給の関係を定量化し,電化と水素間接電化によるエネルギー自立の可能性と同時に発電負荷を下げる為の下記課題を論議した.
①交通部門と産業部門の水素配分
②水を含水素燃料として使う技術開発

Changes in the penetration rate of durable consumer goods in Japanese households and in each country show sigmoid curve.



Source: Cabinet Office “Consumer Awareness Survey”, JETRO (2011) “Survey on Best Selling Products in Asia(2009)”