Hydrogen Energy in Japanese Energy System and Industry

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1. Japan's Target

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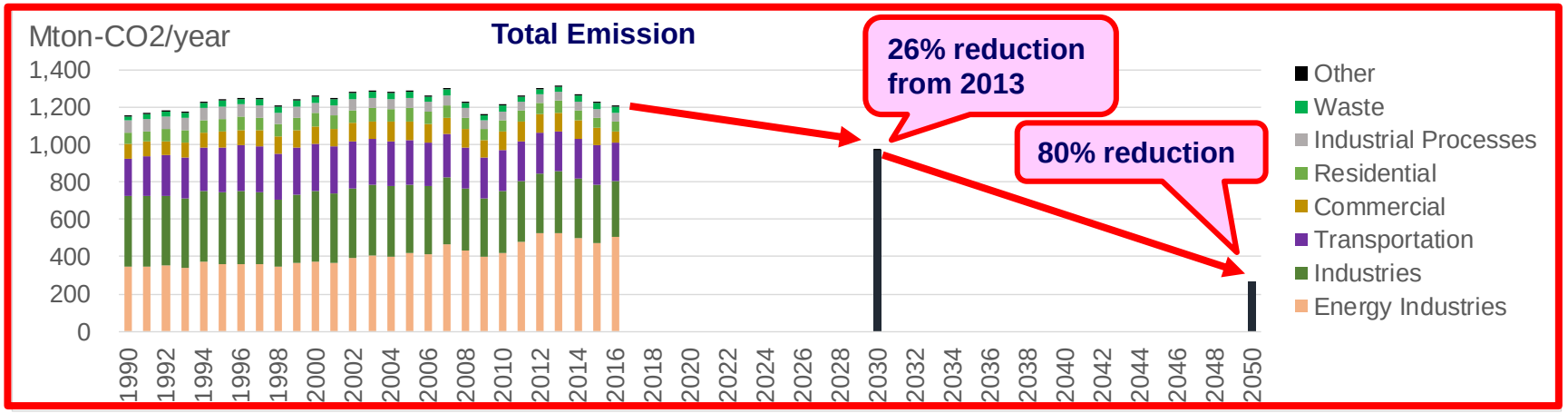
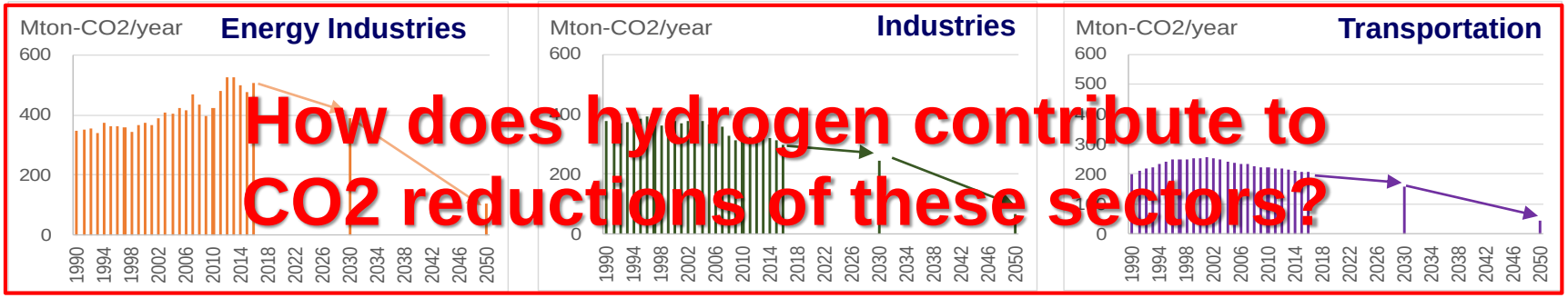
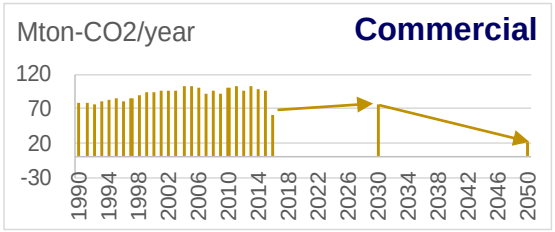
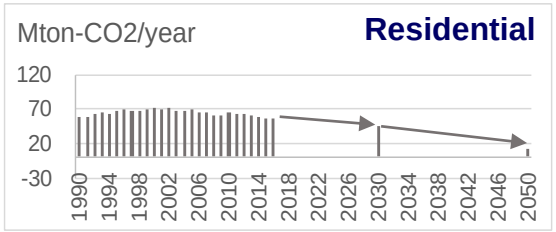
Japan's CO_2 Reduction Target





How does hydrogen contribute to CO2 reductions of these sectors?

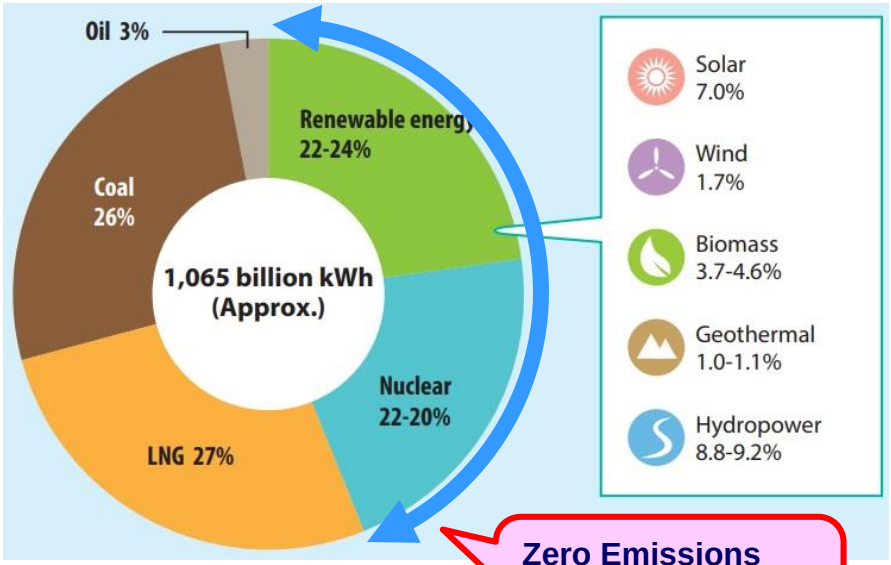




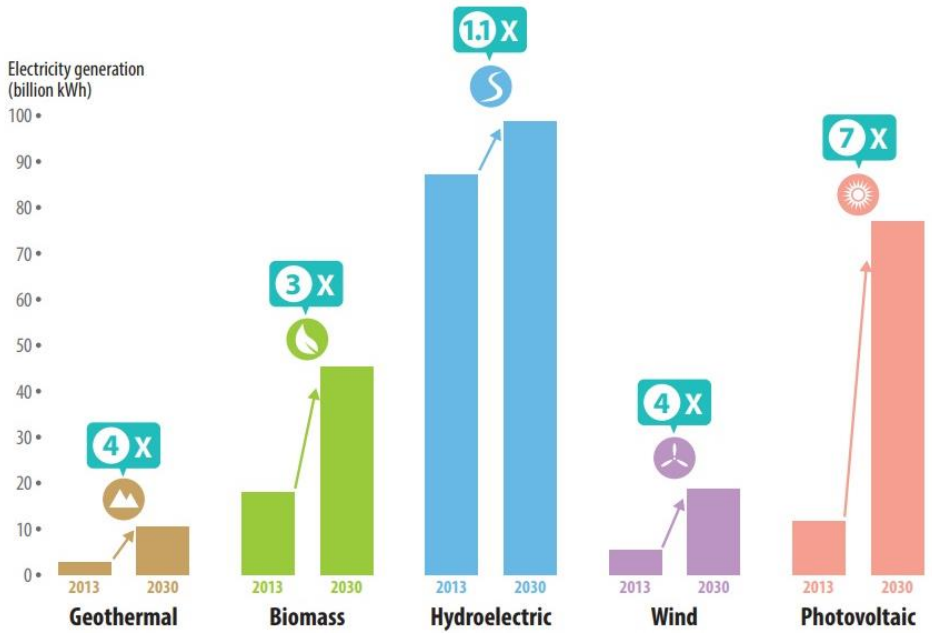
Source: "The GHG Emissions Data of Japan (1990-2016) revised version", National Institute for Environmental Studies, May 29, 2018
http://www-gio.nies.go.jp/aboutghg/data/2018/L5-7gas_2018-gioweb_E1.3.xlsx

Energy industries sector, Industries sector and Transportation sector are key.

Japan's Projected Energy Mix (FY 2030)



Zero Emissions Power Generation 44%



Big jump, but still 7% in energy mix

Source: "METI "Japan's Energy Plan", http://www.enecho.meti.go.jp/en/category/brochures/pdf/energy_plan_2015.pdf

Japan needs to increase ZE Power Generation ratio to 44.

2. Hydrogen Energy in Transportation Sector

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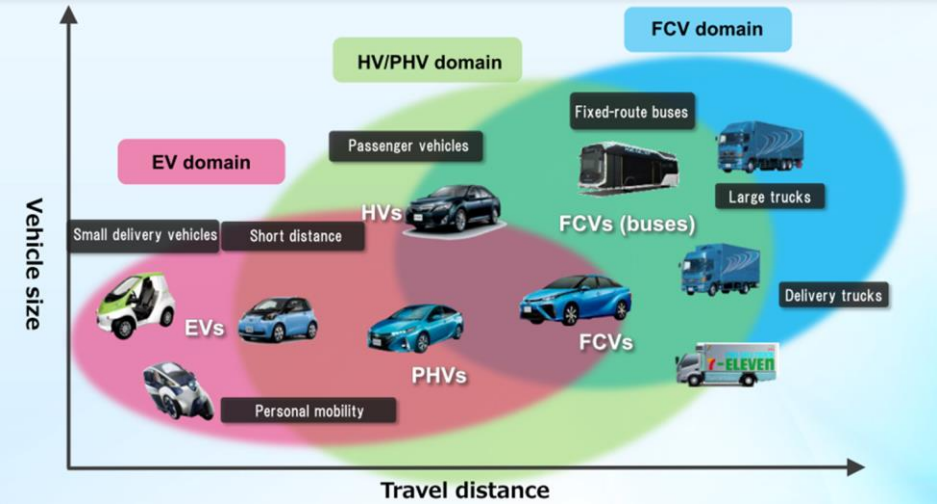
Can BEVs and FCEVs Coexist?

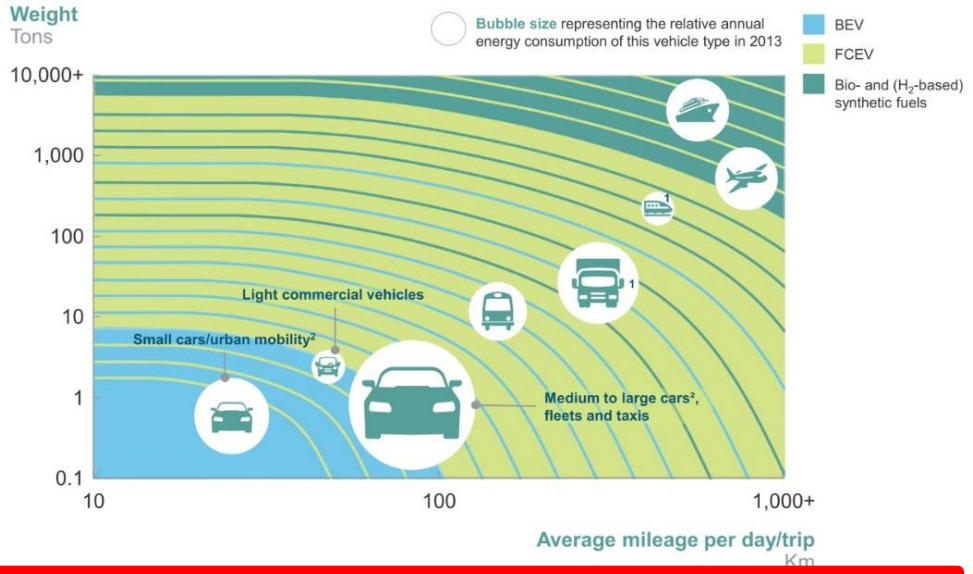


Toyota

Source: Toyota Motor Corporation "Mobility Innovation"
http://www.enecho.meti.go.jp/en/committee/studygroup/ene_situation/pdf/006_009.pdf

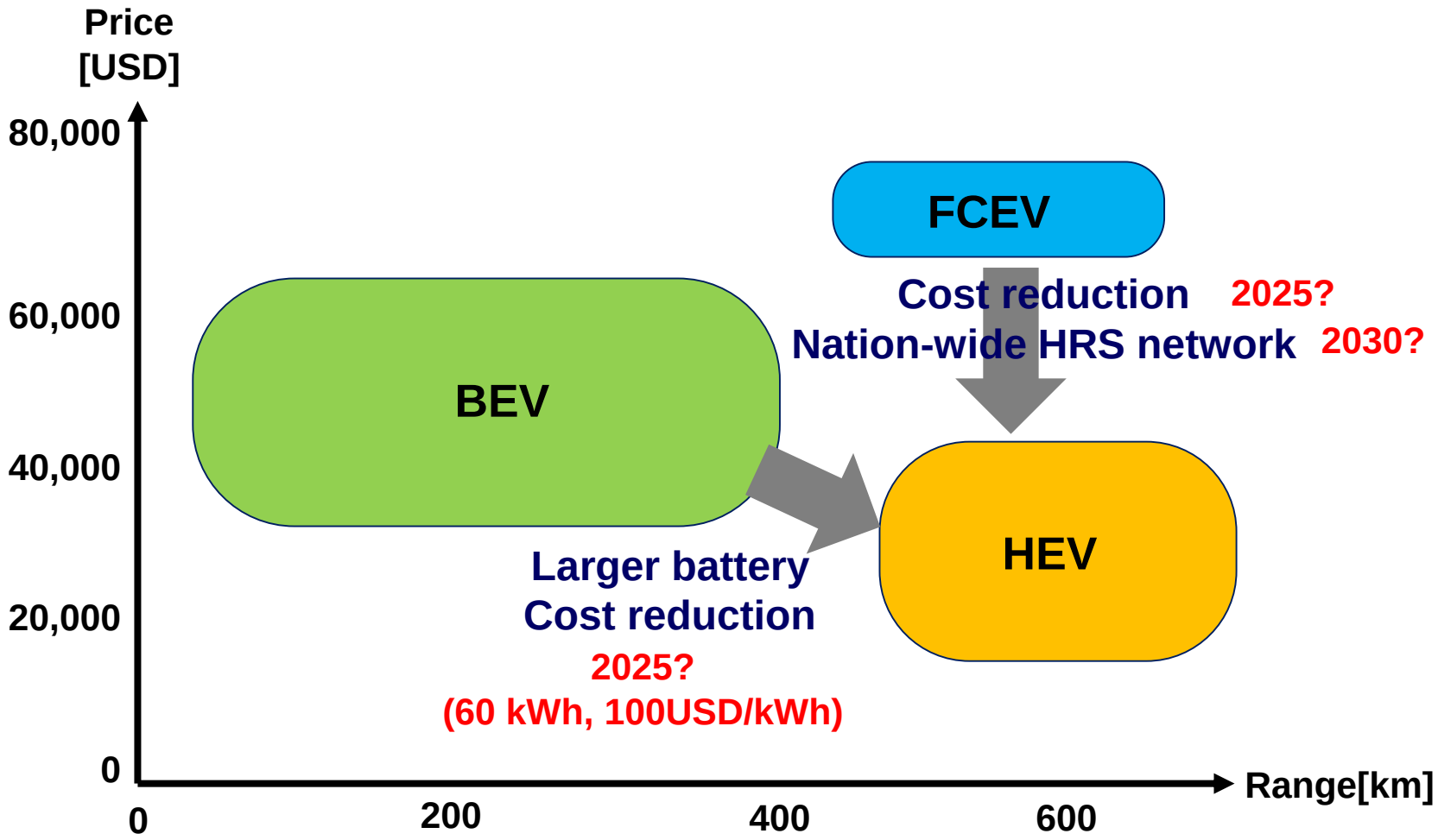
Hydrogen Council

Source: Hydrogen Council,
"How hydrogen empowers the energy transition"
http://hydrogencouncil.com/wp-content/uploads/2017/06/Hydrogen-Council-Vision-Document.pdf



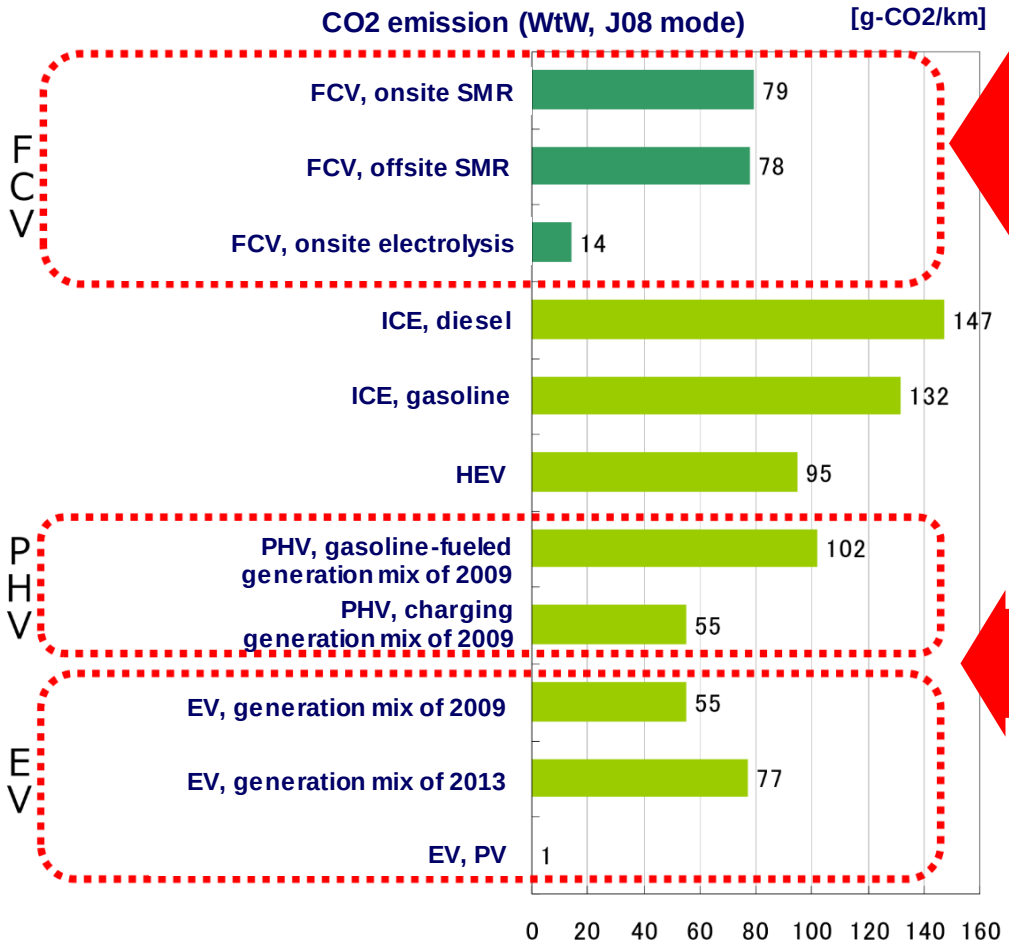
Automakers insist "Coexistence" of BEVs and FCEVs – True?

Market positions of BEV and FCEVs



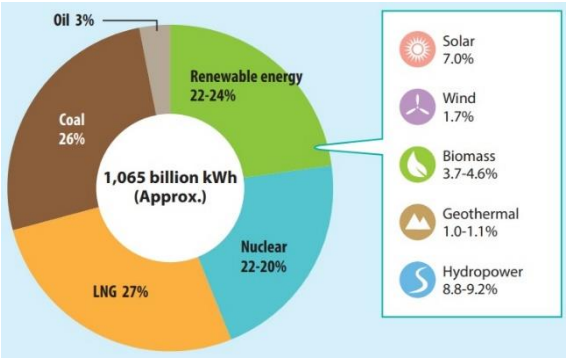
BEVs and FCEVs move to HEV segment in 2025-2030.

BEVs and FCEVs: CO_2 emission per km



FCEV: What is the potential on CO2 free (Low CO2) hydrogen in 2030?

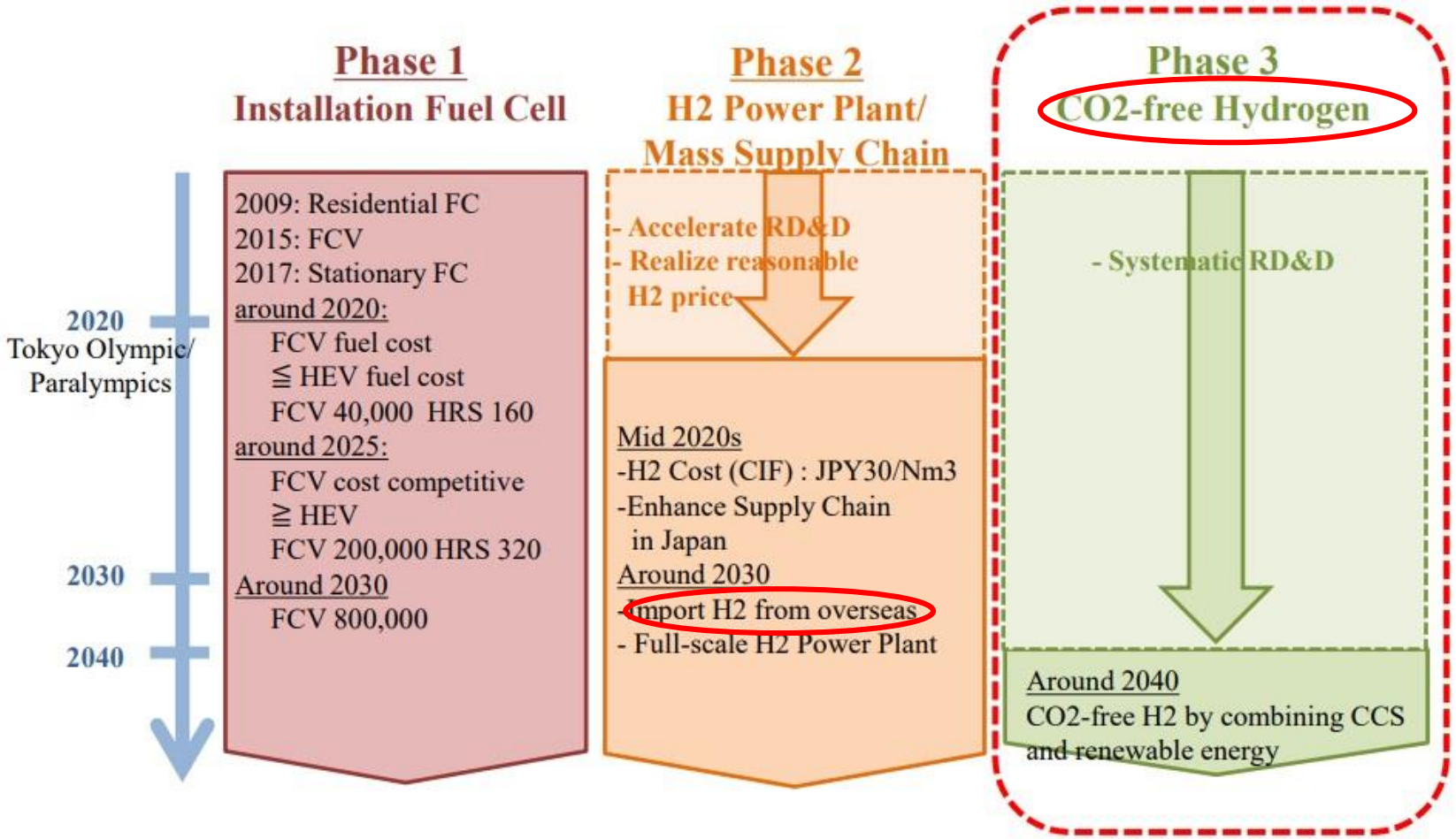
BEV: What is the CO2 emission per kWh in 2030?



Source: METI, "Revised Version of the Strategic Roadmap for Hydrogen and Fuel Cells" (March 22, 2016)
http://www.meti.go.jp/english/press/2016/0322_05.html

What is the CO2 emission from BEVs and FCEVs in 2030?

FCEV: What is the potential on CO2 free (Low CO2) H2



Japan goes to CO2 free hydrogen toward 2030?

BEV: What is the CO2 emission per kWh in 2030?

Nissan Leaf's range

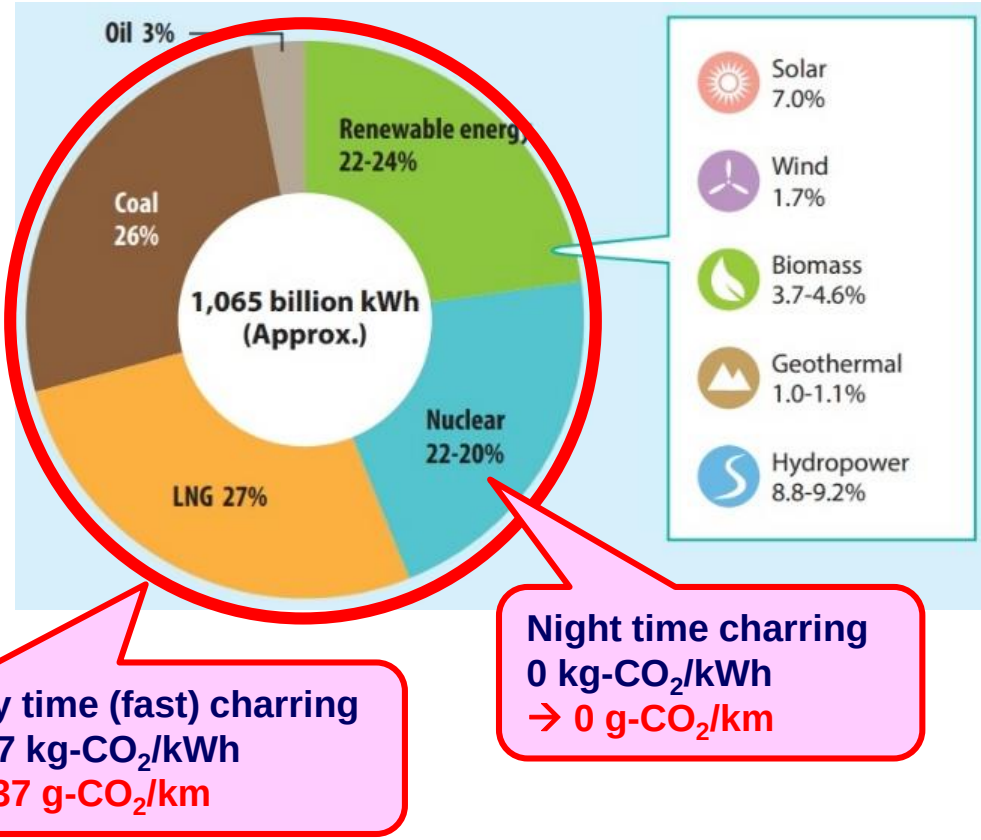
Model S, X, G: 40 kWh battery model: 400 km → 10 km/kWh (best case)

2015 CO2 emission from Grid

0.53 kg-CO_2/kWh

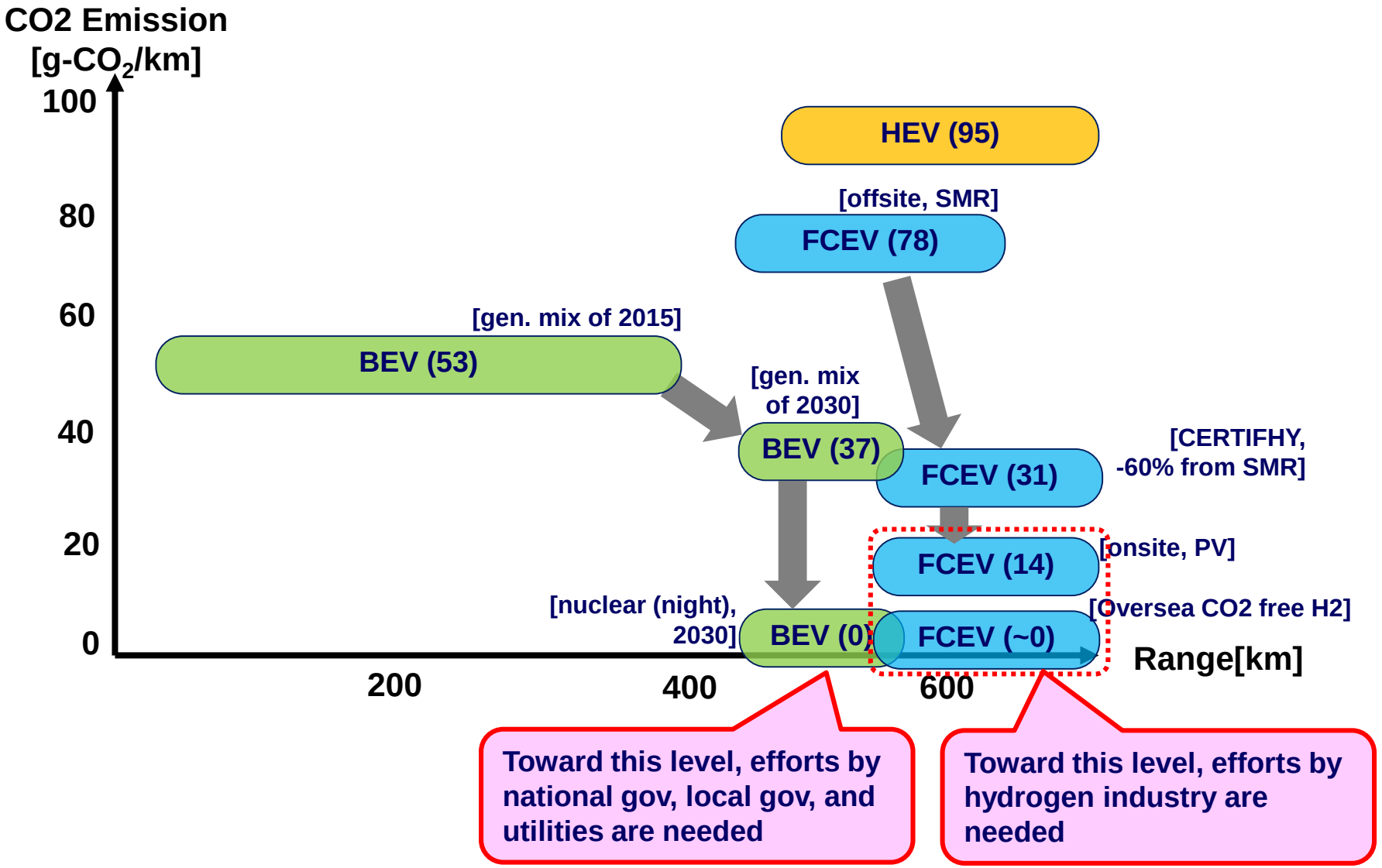
→ 53 g-CO_2/km

2030 CO2 emission from Grid



BEVs: 2030 emission is 37 g-CO_2/km (day) and 0 g-CO_2/km (night)

CO2 reduction potential of BEV and FCEVs



Hydrogen industry's efforts to reduce CO2 is really needed.

3. Hydrogen Energy in Energy Industries Sector (and Industries Sector)

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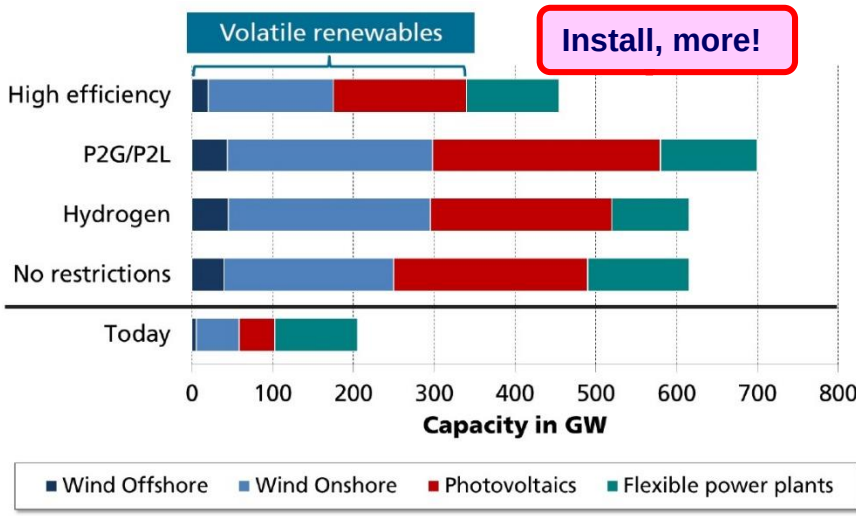
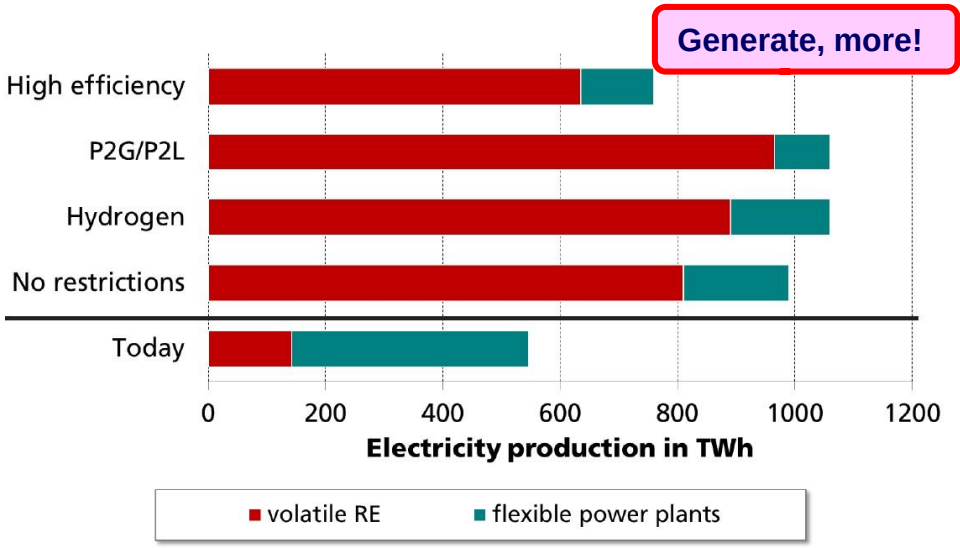
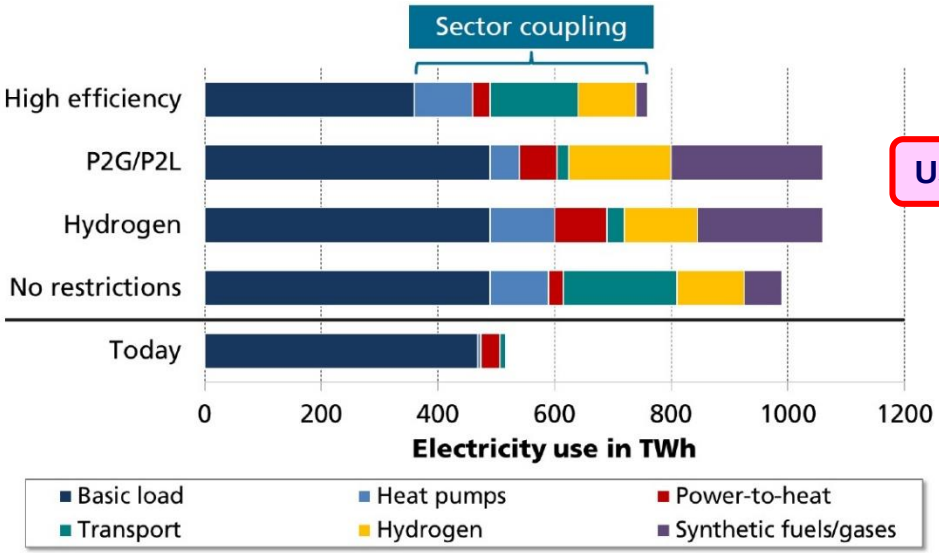
German case: Integrated Energy Concept 2050



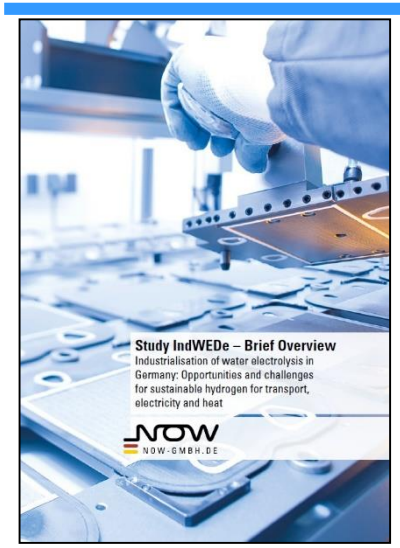


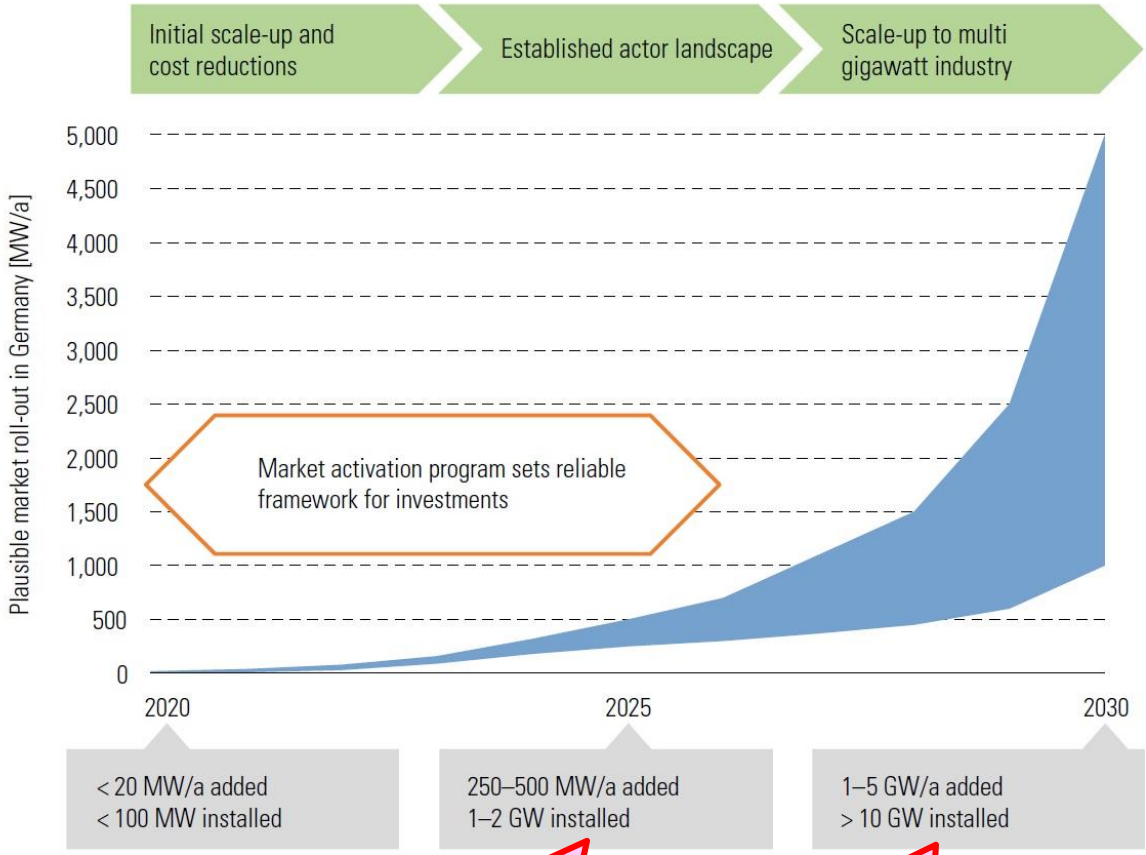


Use, more! (in other sectors)

Toward green grid, they need to generate (green) electricity more!

German case: Roadmap for Electrolysis



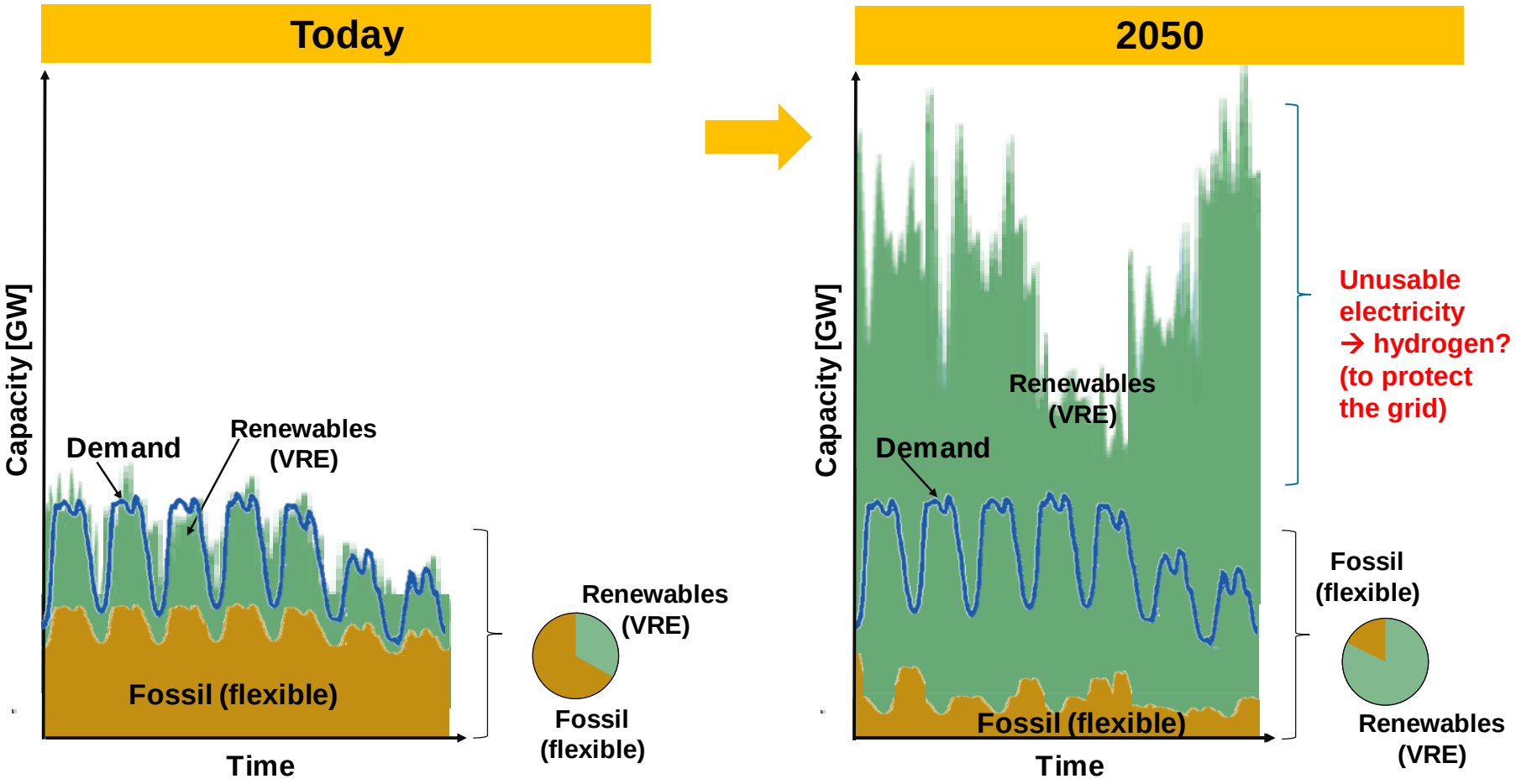


The Grid needs electrolyze installation of 250-500 MW/year

The Grid needs electrolyze installation of 1-5 GW/year

Germany tries to scale up electrolyser industry.

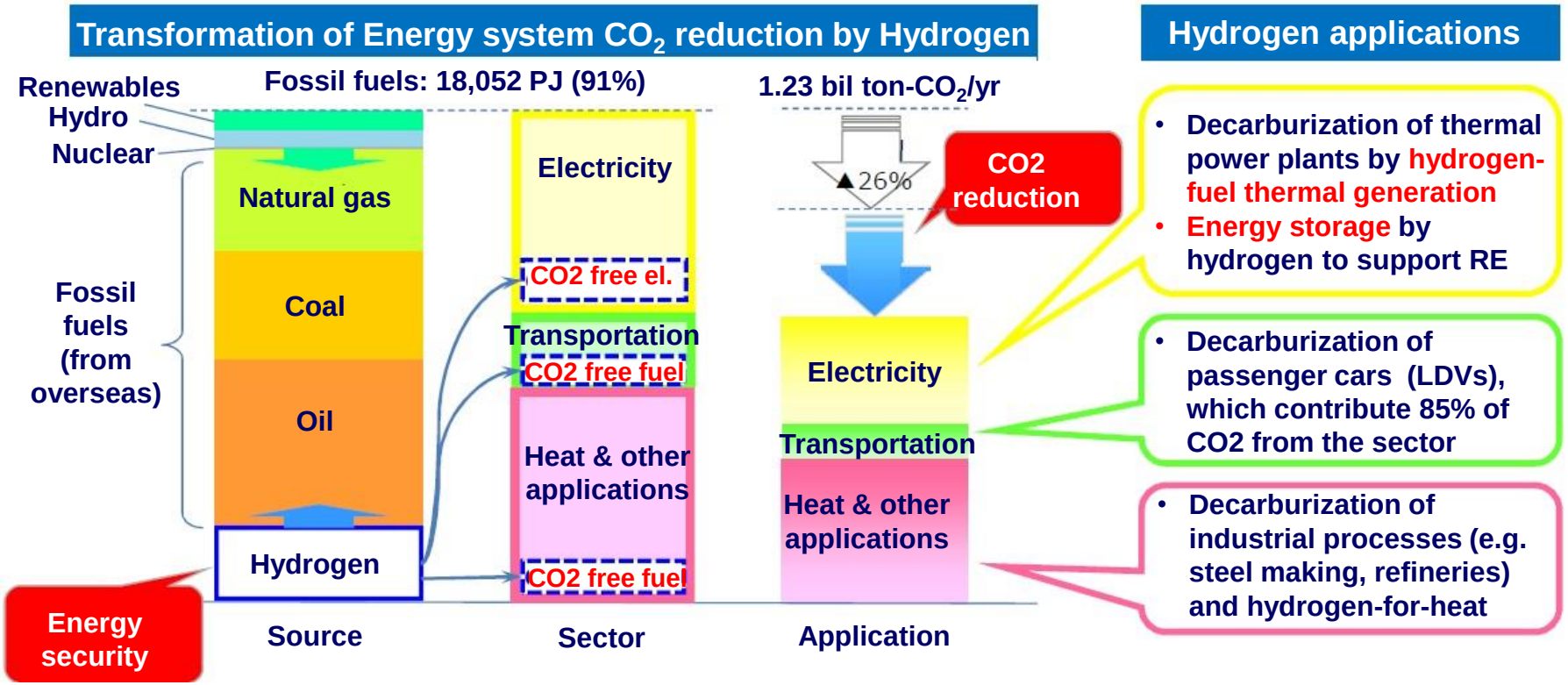
Why they need to generate more?



Source: Tehcnova

Toward green grid, they need to generate (green) electricity more!

Japan: How can we decarbonize the Grid?



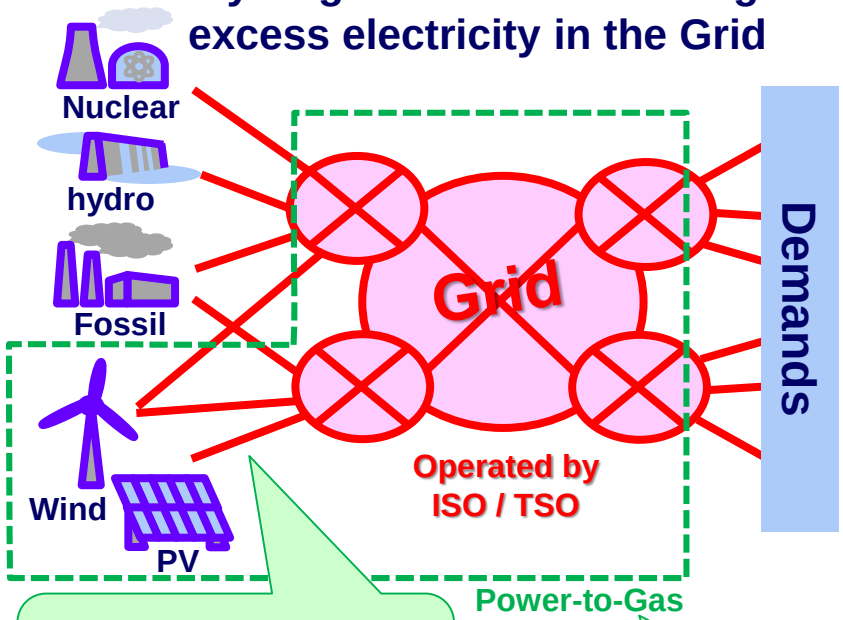
Source: METI (unofficial translation)

To decarbonize the Grid, hydrogen-fuel thermal generation is the key.
How about PtG?

Power-to-Gas: Same name, Different concept

Grid-scale Power-to-Gas

Hydrogen conversion using excess electricity in the Grid

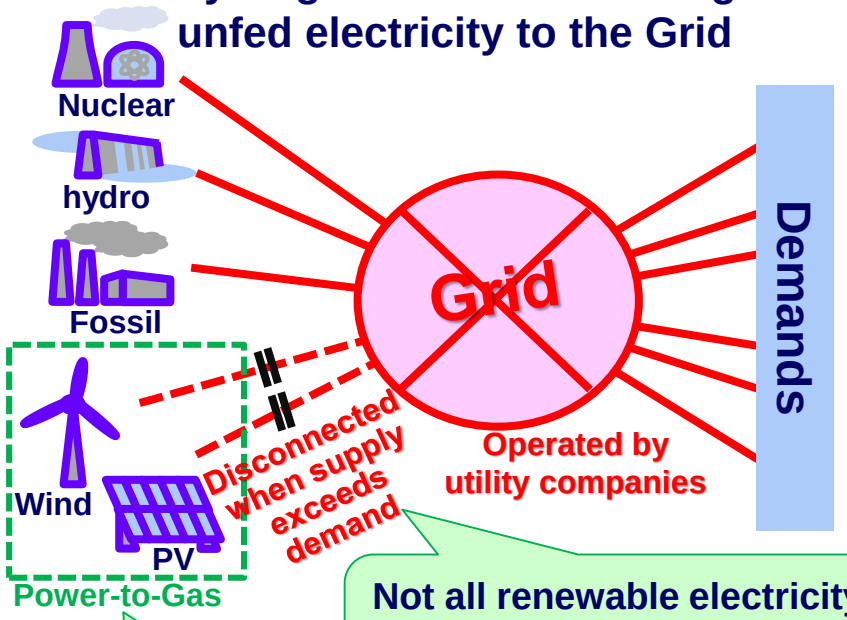


Most of renewable electricity can be fed into the Grid.

Grid needs balancing technology (storage, conversion)
→ Grid-scale Power-to-Gas (or Large scale Power-to-Gas)

Non-Grid Power-to-Gas

Hydrogen conversion using unfed electricity to the Grid



Not all renewable electricity can be fed into the Grid, due to the limited capacity.

Unfed electricity (waste energy) can be converted into hydrogen.
→ Non-Grid Power-to-Gas

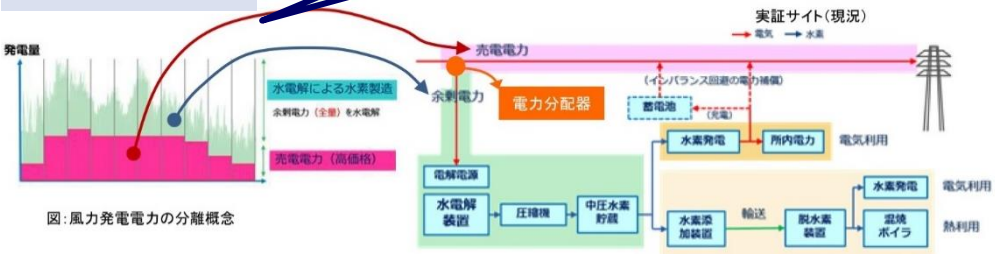
US / Europe: Grid-scale Power-to-Gas (Large scale Power-to-Gas)

Japan: Non-Grid Power-to-Gas

Japan: all “Non-Grid Power-to-Gas”

Tomamae, Hokaido

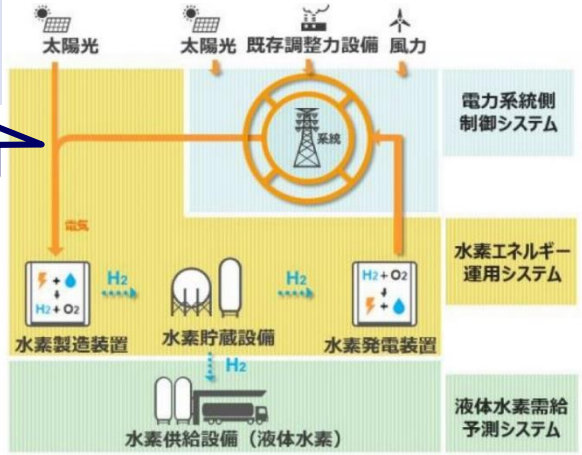
Non-Grid



図：風力発電電力の分離概念

Namie, Fukushima

Non-Grid

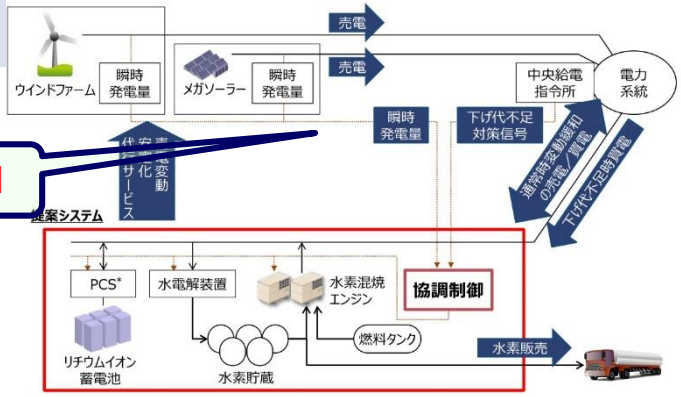


Yamanashi

Non-Grid

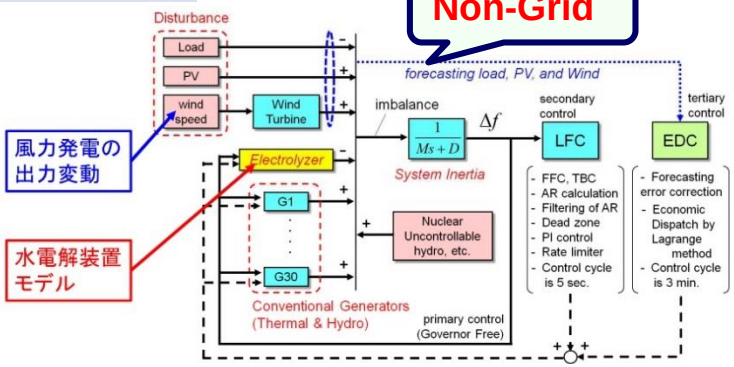
Wakkanai, Hokkaido

Non-Grid



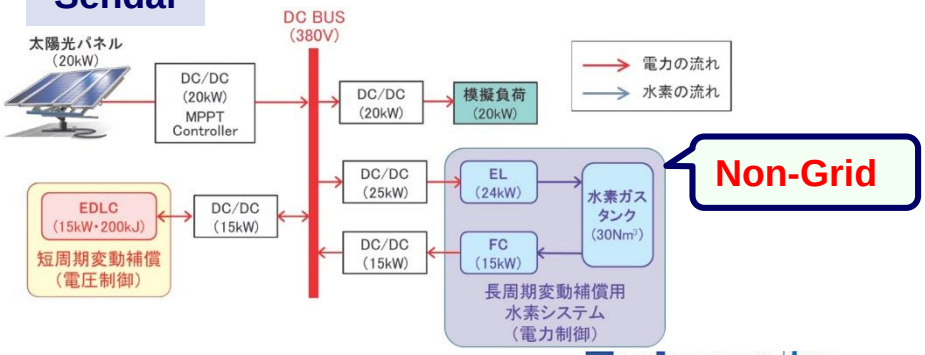
Yokohama

Non-Grid



Sendai

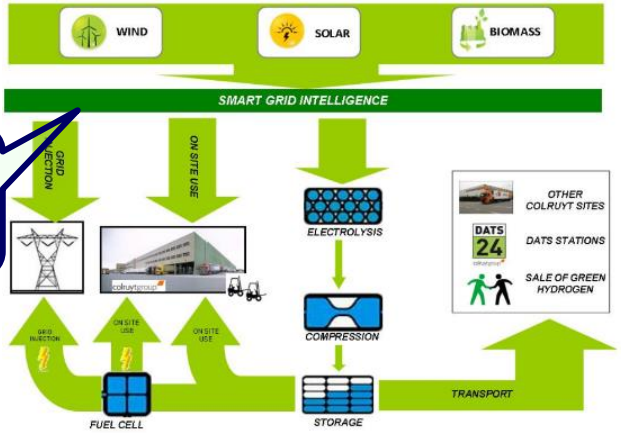
Non-Grid



FCH JU: mostly “Grid-scale Power-to-Gas”

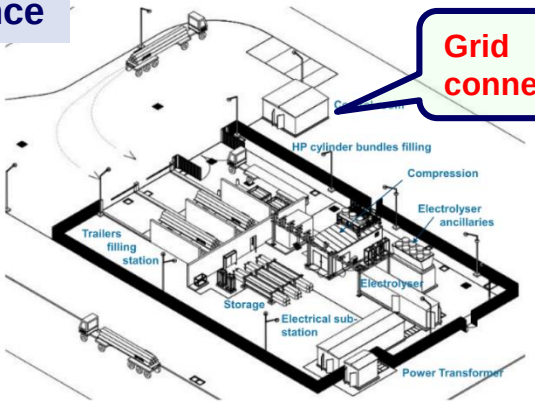
Don Quichote

Non-Grid
1.5MW Wind
& 800kW PV



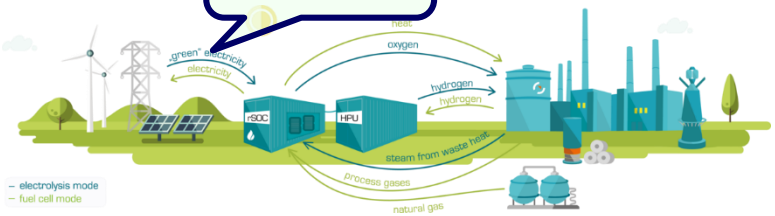
HyBalance

Grid connected



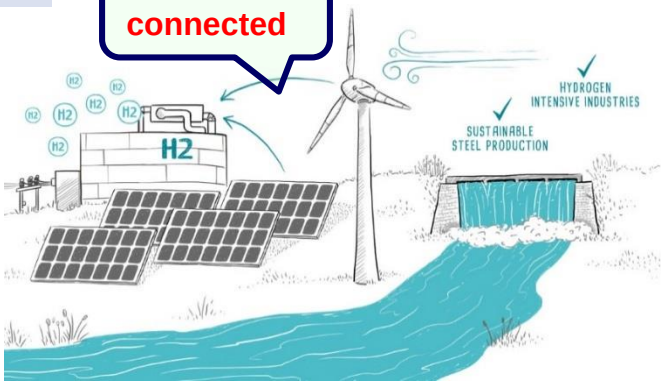
GrInHy

Grid connected



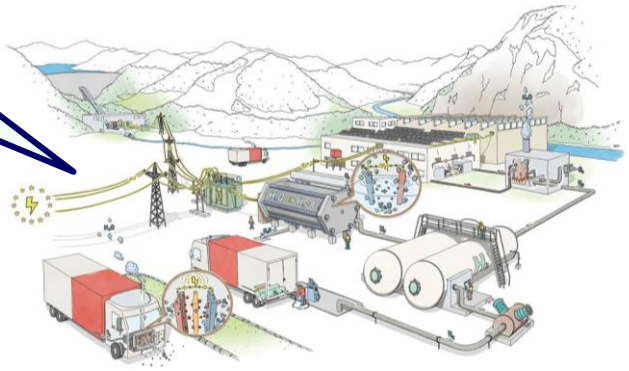
H2FUTURE

Grid connected



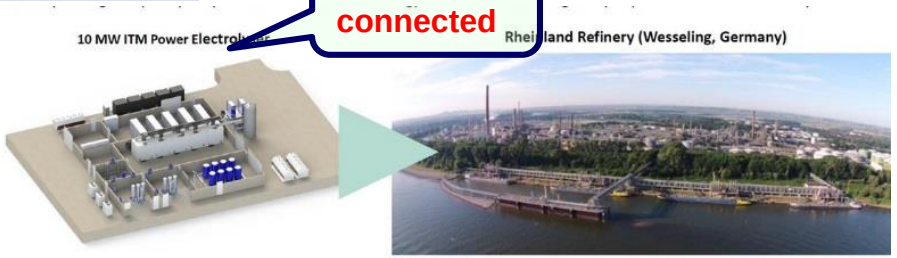
Demo4Grid

Grid connected



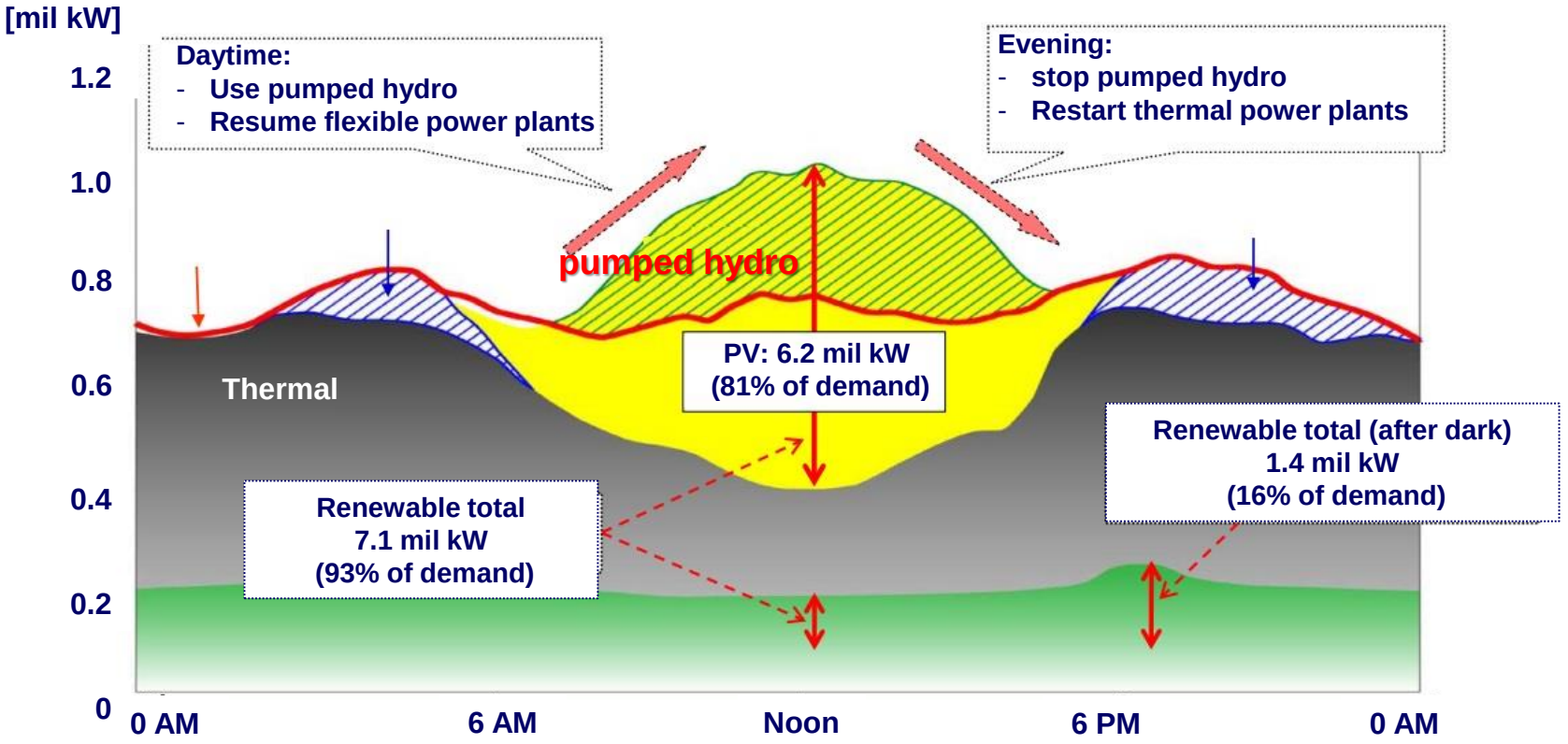
REFHYNE

Grid connected



Non-grid PtG makes sense (case of Kyushu)

Generation profile on May 3, 2018 at Kyushu area

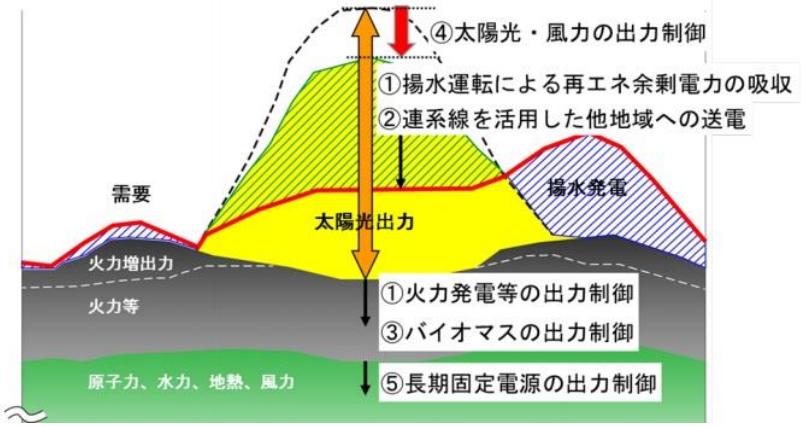


Source: Kyushu Electric "九州本土における再生可能エネルギーの 出力制御について" (unofficial translation)
http://www.meti.go.jp/shingikai/enecho/shoene_shinene/shin_energy/keito_wg/pdf/017_s01_00.pdf

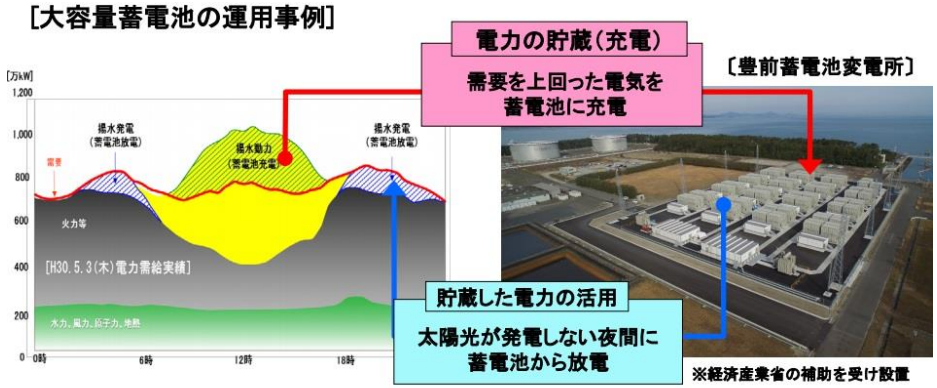
How to cope with increasing generation from renewables?

Non-grid PtG makes sense (case of Kyushu)

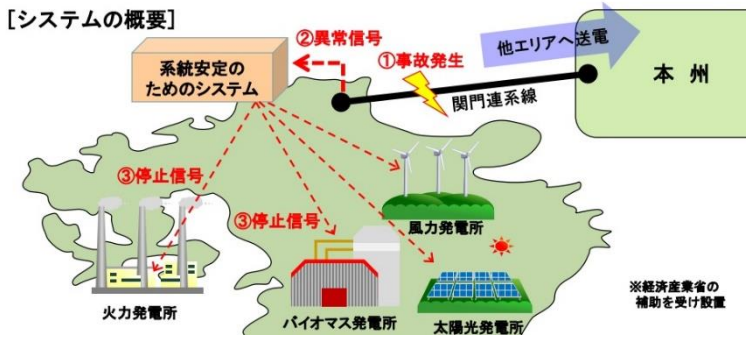
Solution 1: Disconnect VRE



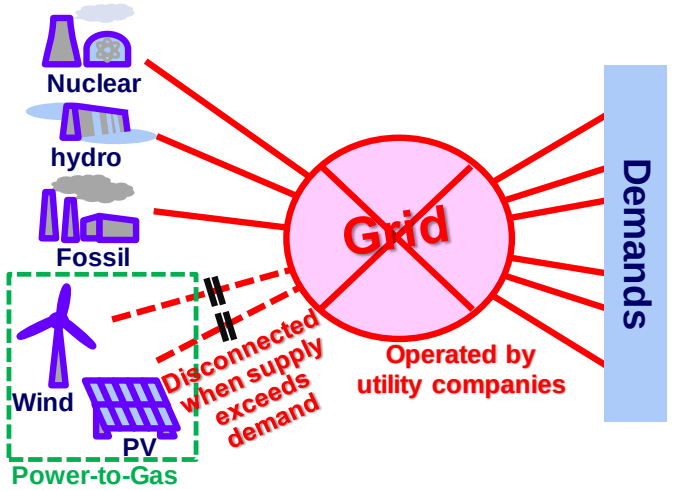
Solution 2: Energy storage (battery)



Solution 3: Flow to other area



Solution 4: Non-grid PtG



Source: Solution 1-3
Kyushu Electric "**九州本土における再生可能エネルギーの 出力制御について**" (unofficial translation)
http://www.meti.go.jp/shingikai/enecho/shoene_shinene/shin_energy/keito_wg/pdf/017_s01_00.pdf

Non-grid PtG can be a solution for temporal unbalance of the Grid.

Japan goes to H2-from-renewables?

Toward a New Era of “Hope-Driven Economy": Prime Minister's Keynote Speech at the World Economic Forum Annual Meeting (January 23, 2019)

- We must invite more and still more disruptive innovations before it's too late. CO2, ladies and gentlemen, could well be the best and most affordable resource for multiple uses. There is artificial photosynthesis, for which a key discovery, one for photocatalysis, was made by Akira Fujishima, a Japanese scientist.
- An old technology of methanation is getting attention anew to remove CO2. It's time now to think about CCU, Carbon Capture AND Utilization. Hydrogen, as both a primary source, and more importantly, a carrier of energy, must become cheaper and more easily affordable. My government is aiming to reduce the production cost of hydrogen by at least 90 per cent by the year 2050, to make it cheaper than natural gas.

出所：Speeches and Statements by the Prime Minister
https://japan.kantei.go.jp/98_abe/statement/201901/_00003.html

Maybe large scale H2 import? Electrolysis?
(if electrolysis, it may change the world (Japan))

Summary

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Summary

- For the meantime, Japan is focusing on Paris target (-26%).
- The largest emitters are energy industries sector, industries sector and transportation sector. We need actions.
- For transportation sector, there may be competition between BEVs and FCEVs. The decarburization of hydrogen is the key.
- Japanese PtG (Non-Grid PtG) is different from European PtG (Grid-scale PtG).
  Sometimes, non-grid PtG makes sense. But how about the future of the Grid?
- PM's speech may change the world (Japan)?

Backup

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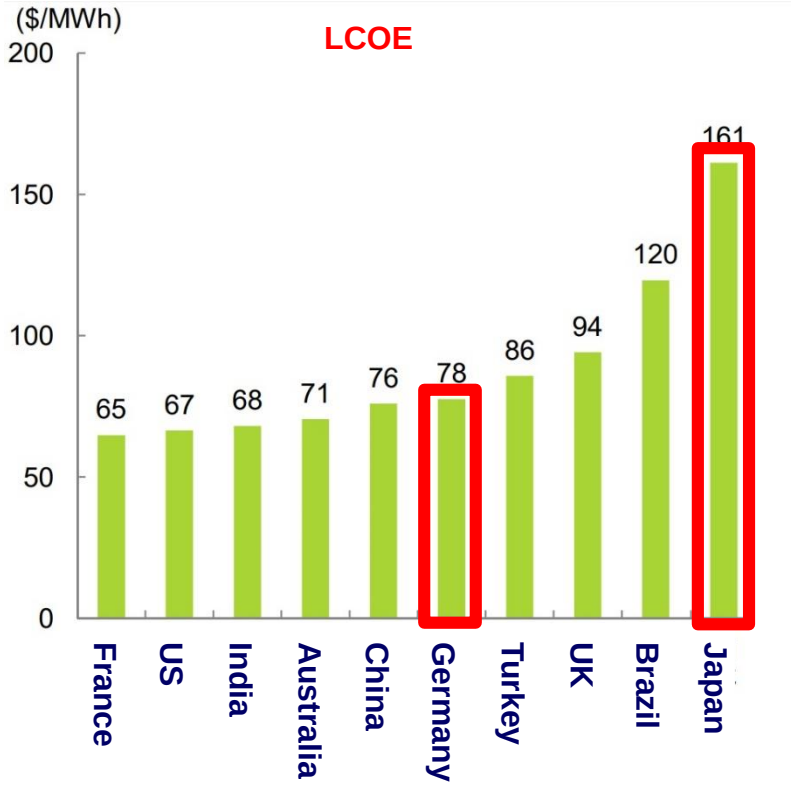
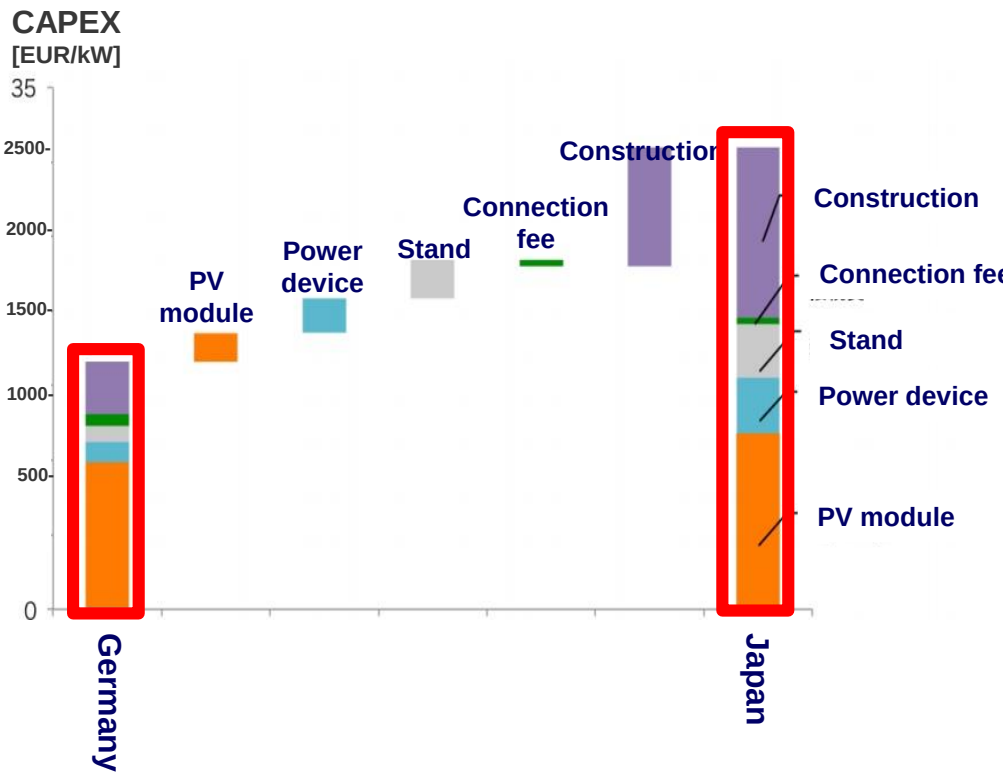
Cost of Renewables: Germany and Japan -- PV

Power Generation Cost



Source: Sumitomo Mitsui Banking Corporation
http://www.smbc.co.jp/hojin/report/investigationlecture/resources/pdf/3_00_CRSDReport044.pdf

CAPEX: Germany and Japan

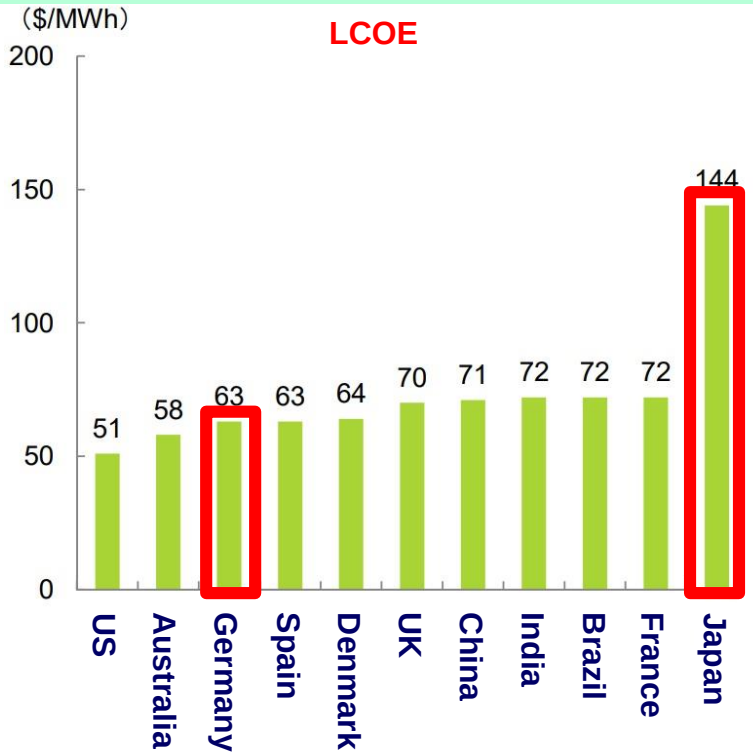


Source: Renewable Energy Institute
https://www.renewable-ei.org/images/pdf/20160113/JREF_Japan_Germany_solarpower_costcomparison.pdf

Japan's PV power station construction cost is much higher than Germany, which pushes up the cost of power generation

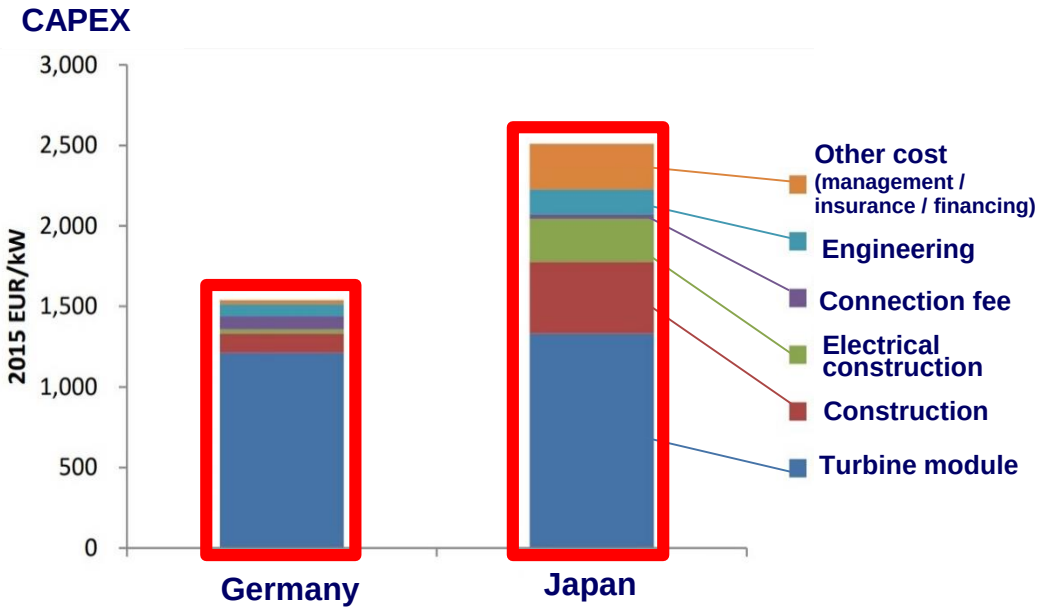
Cost of Renewables: Germany and Japan -- Wind

Power Generation Cost



Source: Sumitomo Mitsui Banking Corporation
http://www.smbc.co.jp/hojin/report/investigationlecture/resources/pdf/3_00_CRSDReport044.pdf

CAPEX: Germany and Japan



Source: Renewable Energy Institute
https://www.renewable-ei.org/activities/reports/img/20170614/20170614_JapanWindPowerCostReport.pdf

Japan's wind turbine construction cost is much higher than Germany, which pushes up the cost of power generation.