

Reality Check for Low Carbon Economy

Auckland, New Zealand, February 2020

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New Players in Town !



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JAPAN

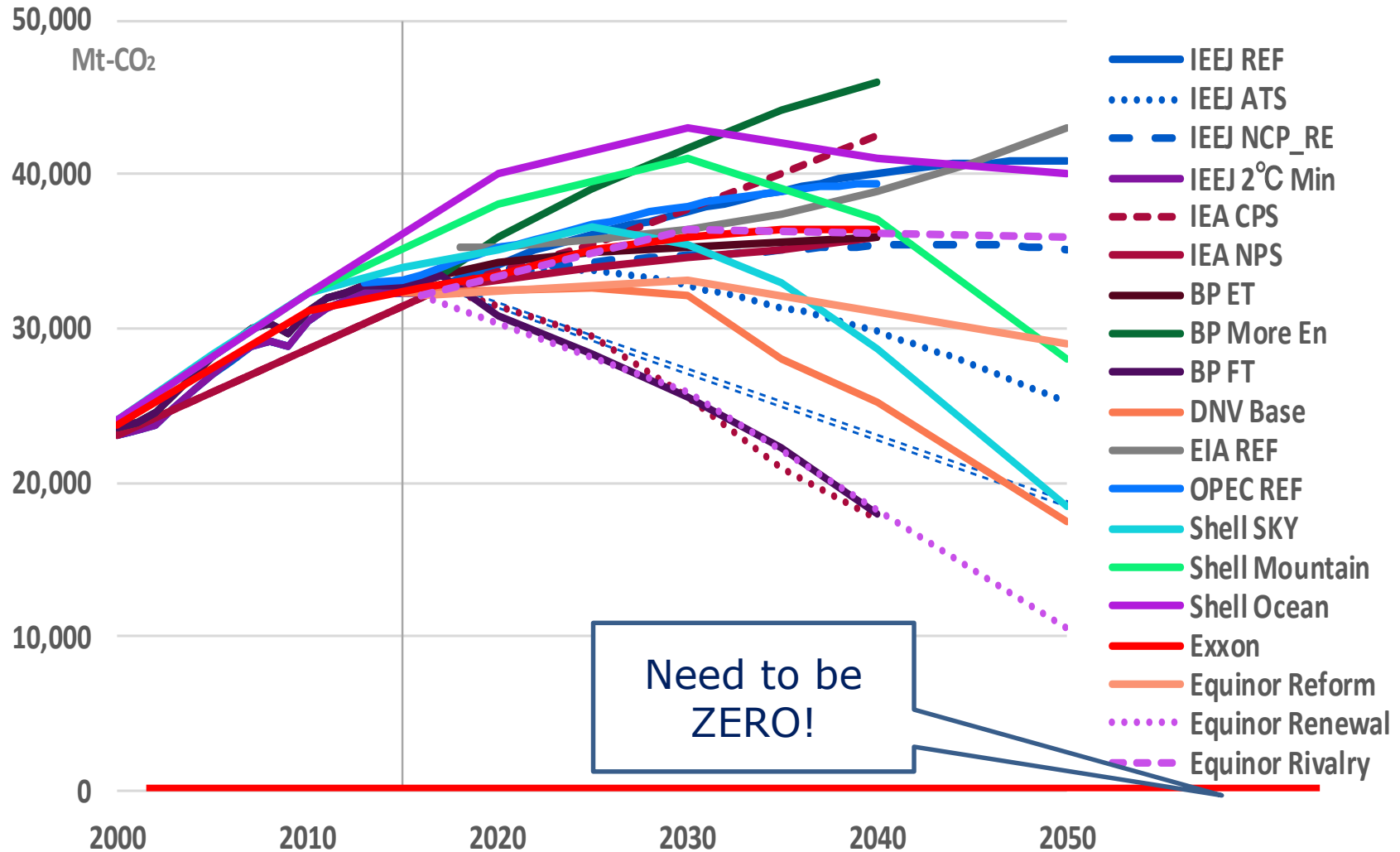


- ◆ Principle of Responsible Investment, **TCFD** and **ESG**
 - “Coal divestment” and **de-carbonization** trend
 - **Rapid** shift towards **EV**
 - **Aggressive** plan to introduce **renewables** → 100% renewables?
 - Rapid shift towards **natural gas**
- ◆ No more fossil fuels? Not even nuclear?
- ◆ Climate Crisis
 - **resilience, adaptation, sustainability**
- ◆ Growing expectations and concerns for **digitalization**
 - Big Data, IT, ICT, robotics...
 - Autonomous driving, shared economy..., Tesla, Uber, GAFA ...
 - Market liberalization, prosumers, blockchain, VPP, smart grid, smart city/ compact city...
 - Intellectual Property Rights, trade conflicts, cyber attack...
- ◆ Global attention for **Carbon-free Hydrogen and ccus**

Importance of All Goals



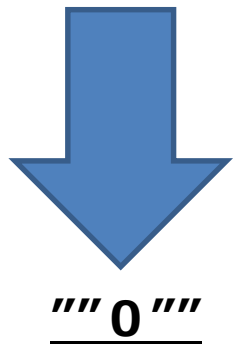
Diverted Views on Global CO2 Emissions



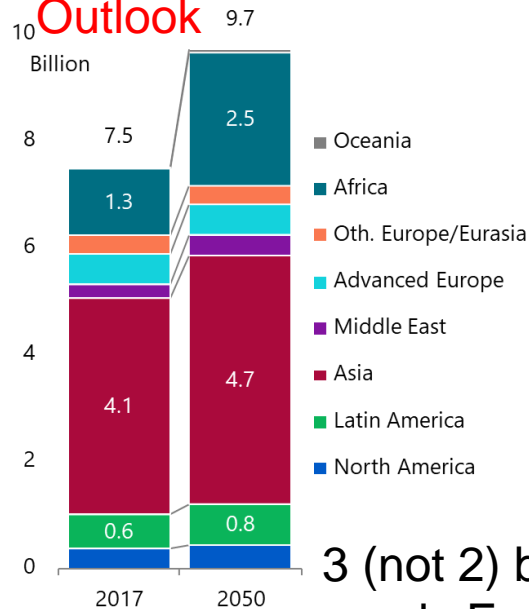
Energy Saving and De-carbonization Essential

the Kaya identity

$$\text{Emissions} = \text{Population} \times \frac{\text{GDP}}{\text{population}} \times \frac{\text{energy use}}{\text{GDP}} \times \frac{\text{carbon emissions}}{\text{energy use}}$$



World Population Outlook



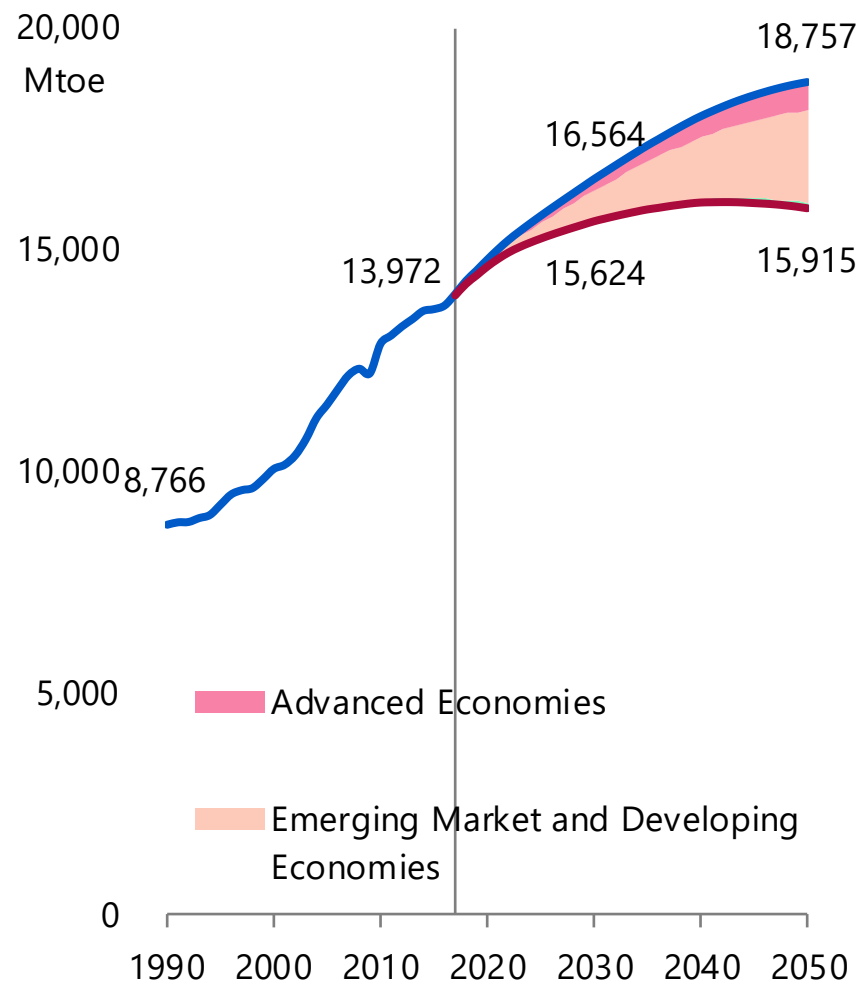
3 (not 2) billion more
needs Energy Access

Energy Intensity *Emissions Intensity*

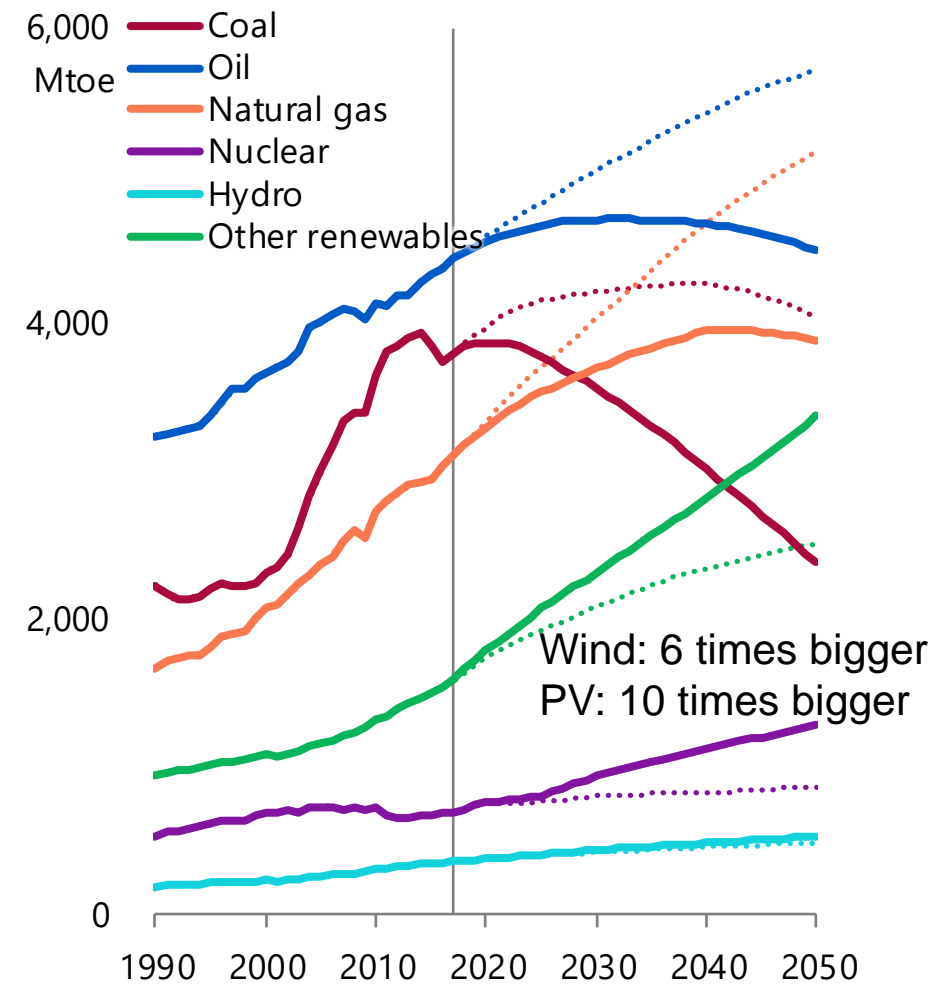
Nuclear
Renewable
CCS

Primary energy consumption

By region



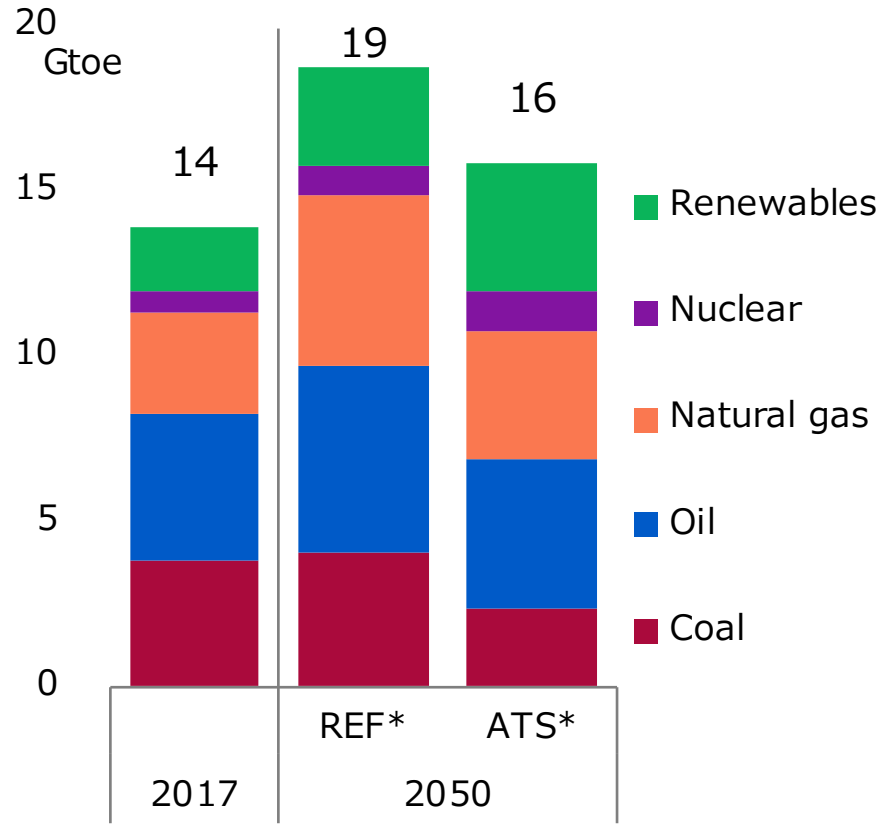
By energy source



Note: Solid lines stand for Advanced Technologies Scenario and dotted lines stand for Reference Scenario.

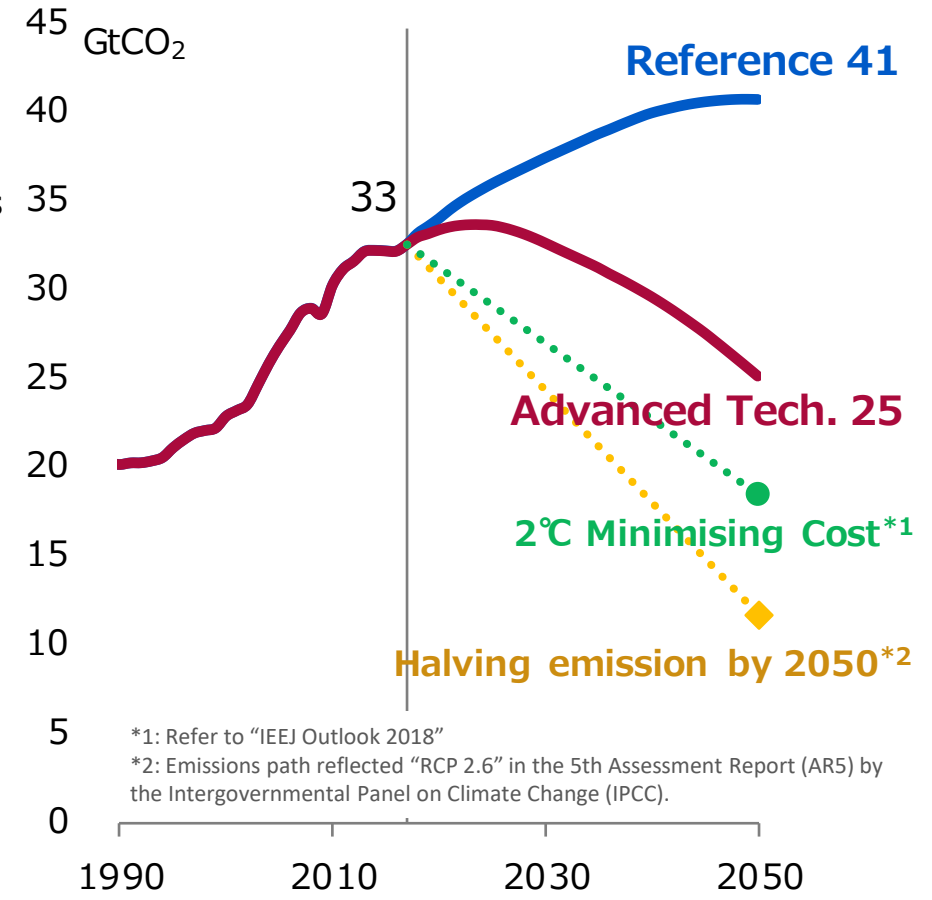
Even after large reduction, 2° C goal still far

◆ Primary energy demand



*REF: Reference Scenario, ATS: Advanced Technologies Scenario

◆ Energy-related CO₂ emissions



*1: Refer to "IEEJ Outlook 2018"
 *2: Emissions path reflected "RCP 2.6" in the 5th Assessment Report (AR5) by the Intergovernmental Panel on Climate Change (IPCC).

In the Advanced Technologies Scenario, dependence on fossil fuels drops to 70%, still high level. Energy-related CO₂ emissions peak at the middle of 2020s and decrease by 23% vs. 2017 in 2050. To keep temperature rise to below 2 degrees Celsius, additional programs and innovative technologies are required.

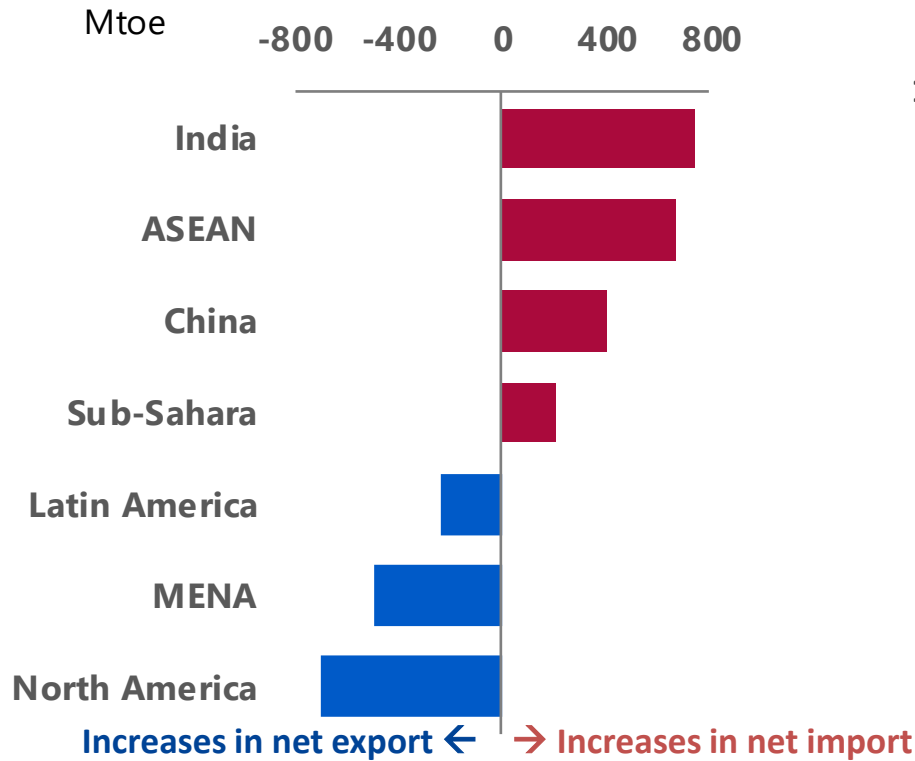
In Asia..... There's Need for Cleaner Air

In Asia,
Not only climate change challenge
but also **the other Es** (Economic
Growth and Energy Security)
need to be addressed

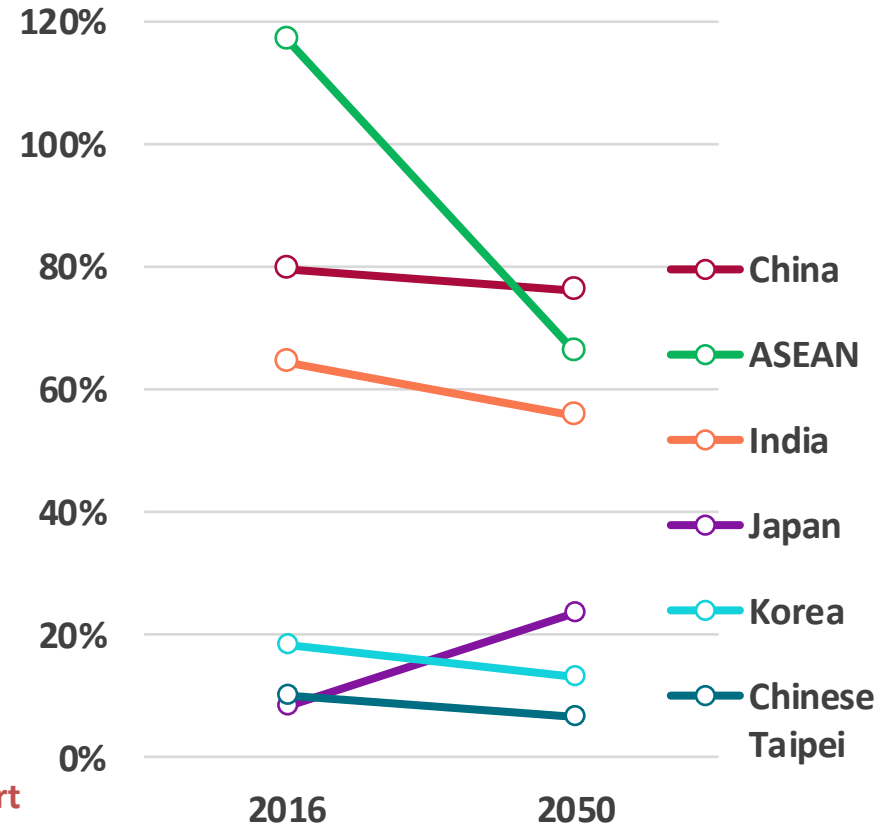


In Asia Energy Imports will Increase

❖ Increase of net import energy (2016-2050)



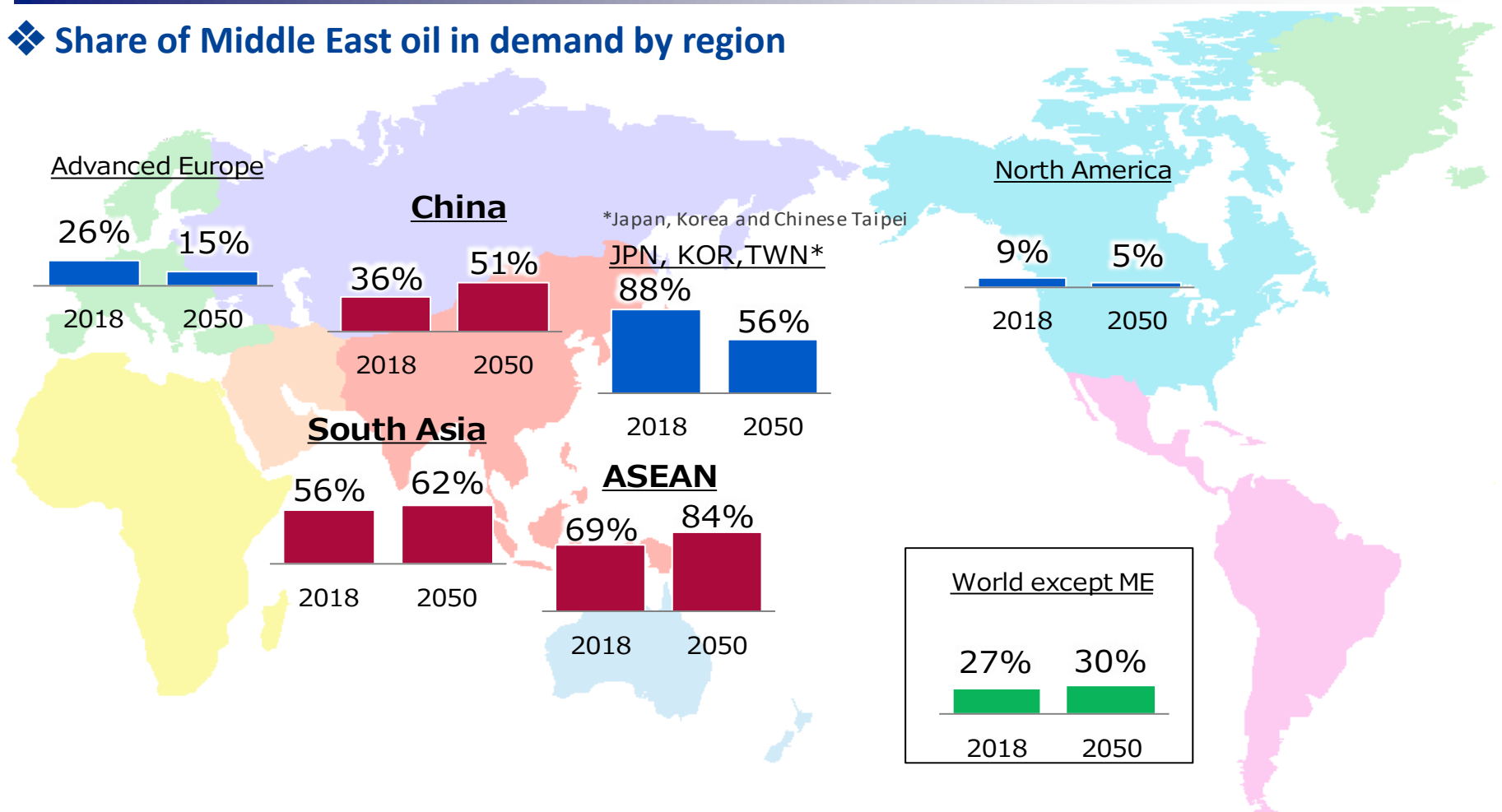
❖ Self-sufficiency rate



- ◆ Energy imports of Asia will increase dramatically.
- ◆ 80% of energy traded globally will be consumed in Asia.

Only Asia pushes up dependence on ME

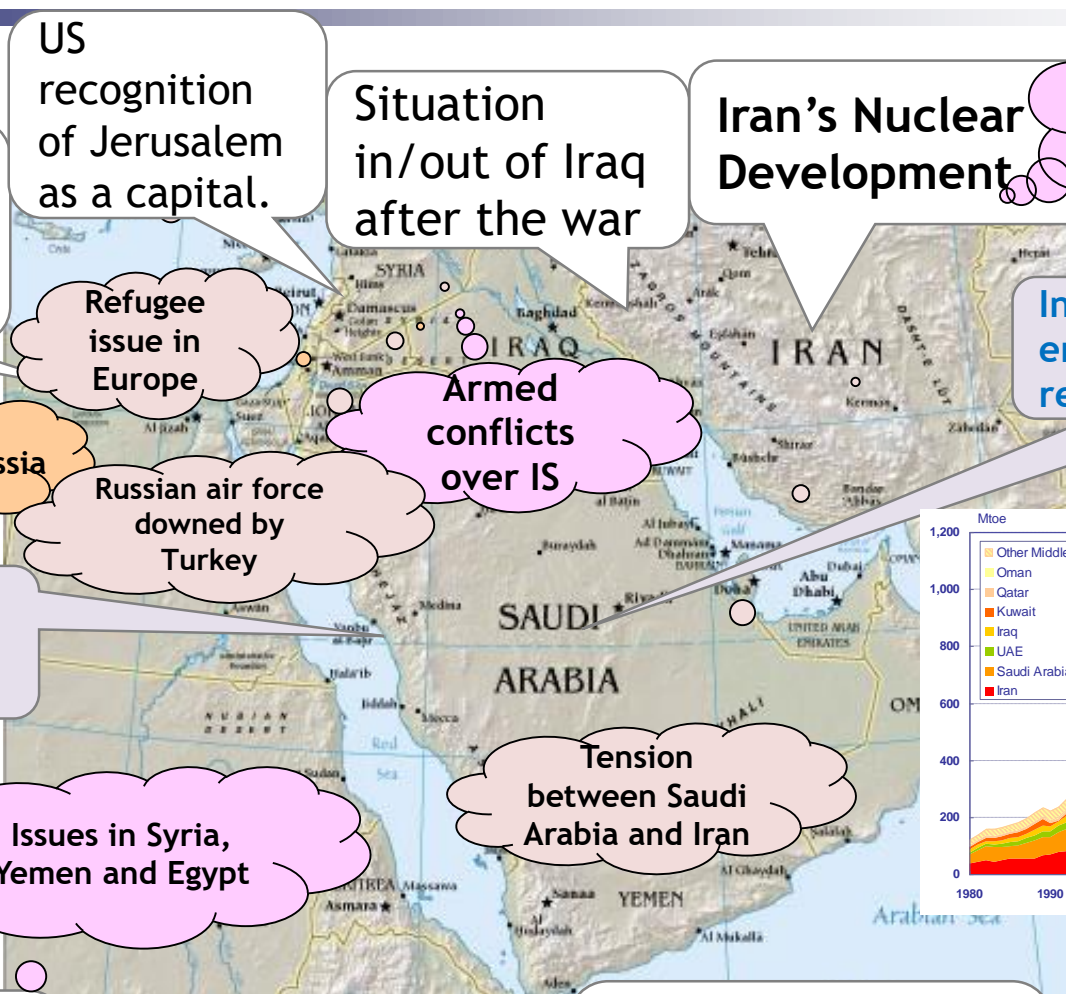
Share of Middle East oil in demand by region



Developing Asia increases dependence on Middle East oil and mitigating risk of supply disruption remains one of the priority issues.

Meanwhile, North America and Advanced Europe reduce the dependence rapidly but would be affected by higher oil price when emergency due to higher dependence at the global level.

Uncertainty and Instability Continue in MENA



Terrorist attacks in Paris & Belgium...
Opacity of Peace in the Middle East

US recognition of Jerusalem as a capital.

Situation in/out of Iraq after the war

Iran's Nuclear Development

Lift of economic sanction and Iran's return to market ⇒ US withdrawal

Gaza Conflict

Refugee issue in Europe

Armed conflicts over IS

Increasing domestic energy demand and its repercussions

Air raid by Russia

Russian air force downed by Turkey

Wide spread Arab Spring movements

Issues in Syria, Yemen and Egypt

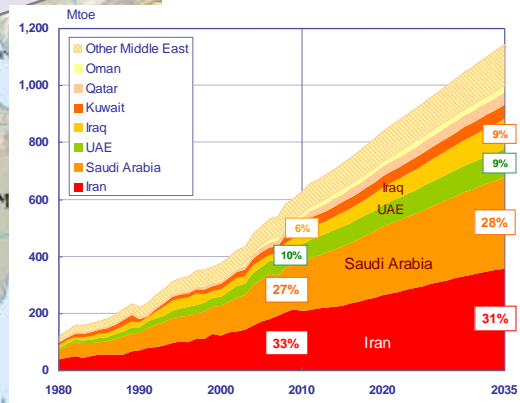
Tension between Saudi Arabia and Iran

Spread of protests and/or discontent among Arab citizens against US

Insecurity factors surrounding current ME Governments /systems.

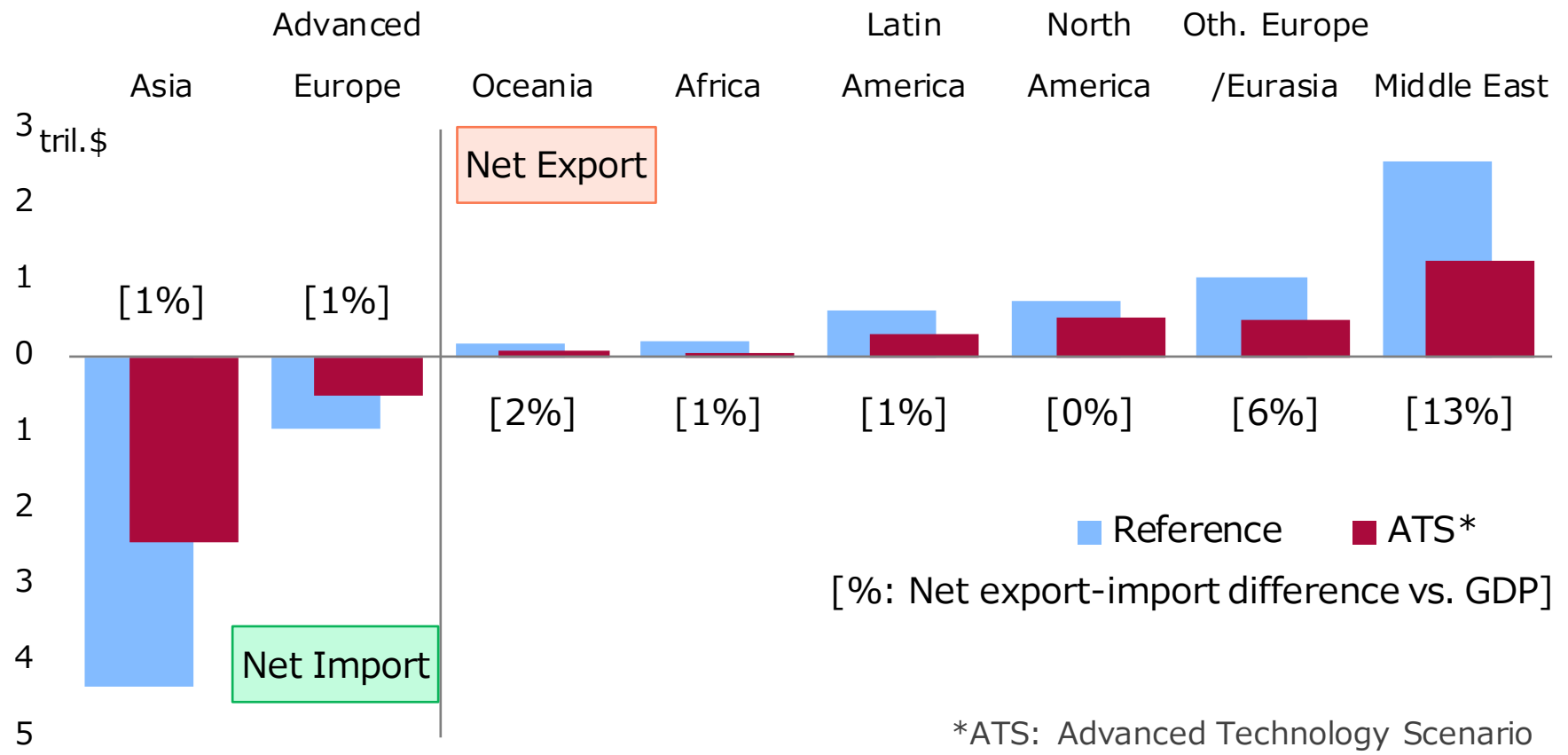
Arrest and imprisonment of Royal Families and Cabinet Ministers by KSA Anti Corruption Committee (Nov. 2017)

Potential threats of terrorists' attack on oil facilities



Unclear oil revenue for the Middle East

❖ Net energy exports / imports by region (2050)



In the Advanced Technologies Scenario, demand growth of fossil fuels slows and prices are lower than in the Reference Scenario. Asia and Advanced Europe can reduce net import bills a lot. Meanwhile, oil and gas export revenues for the Middle East could decrease by the equivalent to 13% of its GDP.

How to Accelerate Energy Transformation?

- ◆ **Need Bulk Introduction of Clean Energy**
(renewables, nuclear, fossil fuels with CCS/CCUS)
- ◆ **Need a New Way of Thinking**
(New energy system, new infrastructure, new business scheme, recycling, etc.)
- ◆ **Need All to Play Roles (supply & demand sides)**
- ◆ **Need Lots of Data (Big Data) and Digital Technologies**

Reality Check

- Dash for Coal Divestment
- More Clean Energy (Nuclear, Renewables)
- Dash for EV

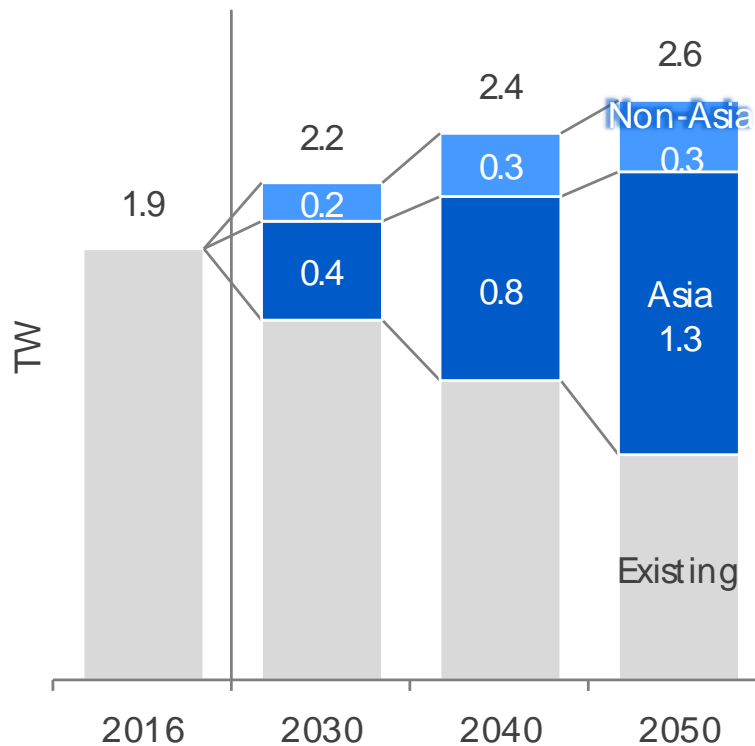
and

- Economic Growth, Clean Air, Energy Security, Sustainability, Resilience, etc.

Impact of banning construction of new coal-fired power plants

from IEEJ's Outlook 2019

◆ New coal-fired power plant capacity [Reference Scenario]



IEEJ Outlook

2019

- 2050年に向けた展望と課題 -

エネルギー・環境・経済

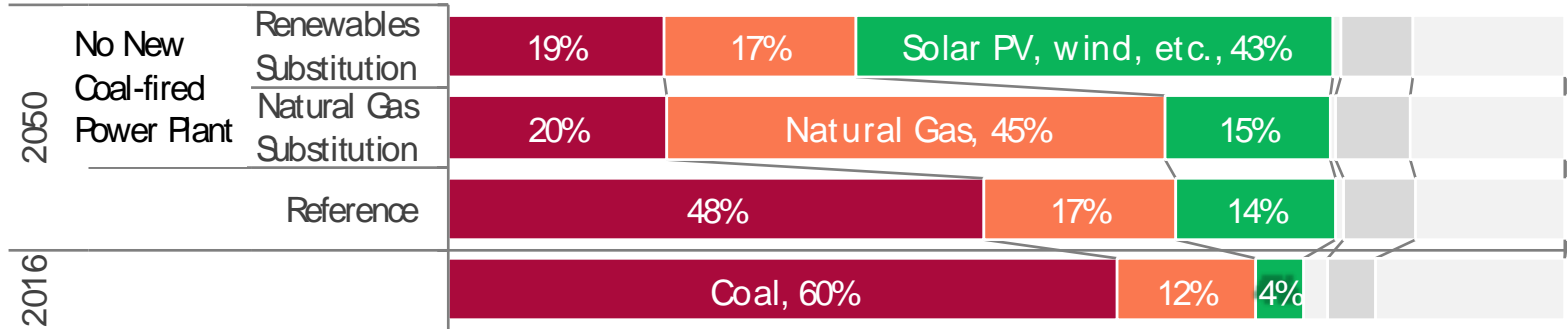
2017年10月

IEE
JAPAN
一般社団法人
日本エネルギー・経済研究所

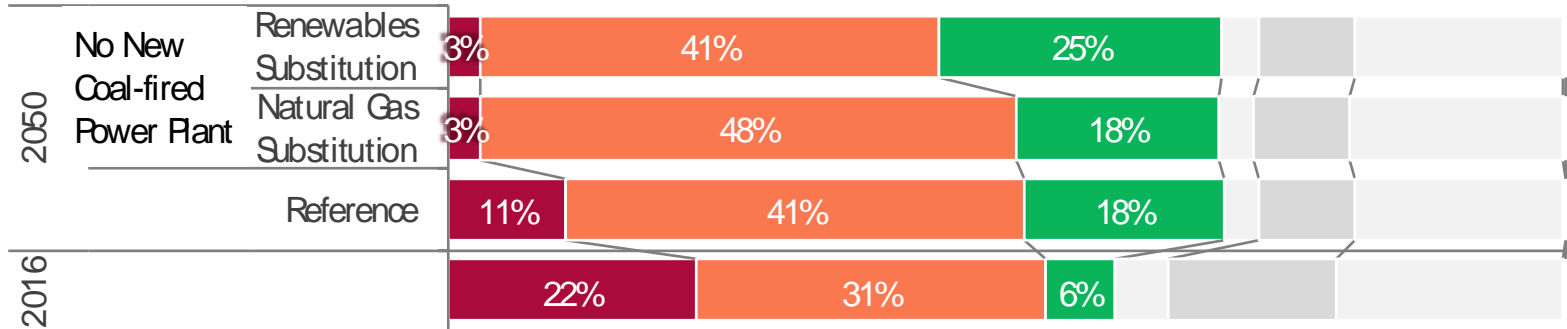
Drastic transition of power generation mix! Especially in Asia!!

❖ Power generation mix

Asia



Non-Asia

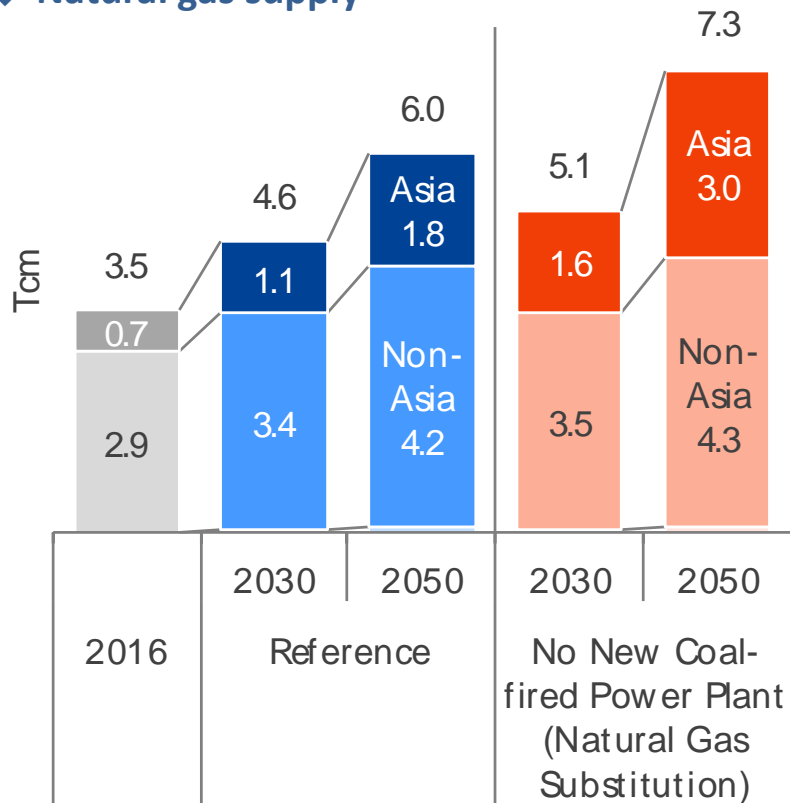


Since Asia largely depends on coal-fired power generation, abolishment of coal-fired power plant construction means drastic transition of power generation mix.

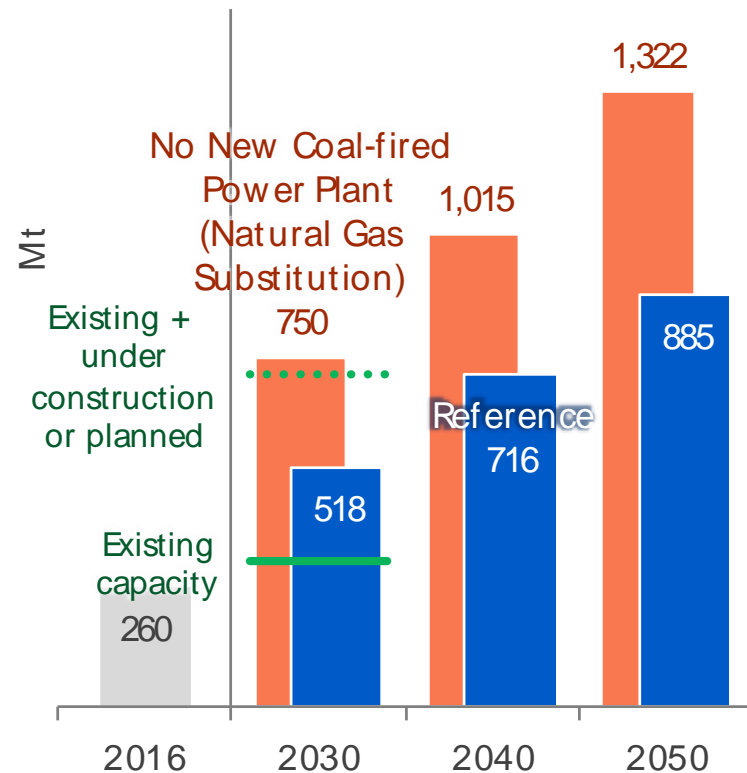
On the other hand, transition is relatively limited in non-Asia. Even if solar PV and wind substitute for coal-fired power generation, natural gas remains the largest share.

Substitution of natural gas requires dramatic expansion of supply

❖ Natural gas supply



❖ LNG demand



Natural gas consumption in 2050 reaches twice the current level. Cumulative consumption until 2050 may exceed the proven reserves.

All possible resources need to be developed no matter how difficult.

LNG demand in 2030 is 3 times the current level.

To meet enormous demand, even LNG projects without definite developed plan need to come into operation.

Victoria concordia crescit

(Victory comes from harmony)

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An entire ban on construction of coal-fired power plants



3 Gt~7 Gt of
CO₂ reduction



Drastic increase of
alternative energy demand

Energy security challenges
such as natural gas /
electricity stable supply,
economics, etc.



The country should promote to abolish coal-fired power generation that can do so.

If difficult, or with better CO₂ reduction measures, they should assess their priorities, making effort quickly to replace low-efficiency coal-fired power plants with high-efficiency ones and reduce dependency on coal-fired power generation.

Always keep in mind.....

Are you prepared to support for the drastic energy transition in developing Asia?

Think it over.

Shift from coal-fired power generation is only one means, and that the end is to address climate change.

On a larger scale,

Climate change is one of humanity's great challenges, but not the only one.

Nuclear: OECD Countries Struggle while China and Russia are Going Forward

1. U.S.

: **The competitiveness of nuclear energy is eroded** by low gas price thanks to Shale Revolution. "Zero Emission Credit (ZEC)" has been introduced in some Liberalized State.

2. U.K., France, Finland

: The challenge is how to overcome **cost increase caused by the introduction of the third generation of reactors**. In many countries, nuclear energy is essential for addressing Climate Change. UK introduced CFD(Contract for difference) and now considering RAB(Regulated Asset Base)

3. Germany

: **Phasing out nuclear has made difficult it to reduce GHG** because brown coal is used for back up of intermittent renewable energy.

4. China and Russia seem to increase nuclear steadily

: **China** ⇒ **7 reactors** was completed in 2018.

Now they have **44 (in operation) and 14 (under construction)**. + **Overseas**

: **Russia** ⇒ **1 reactor** was completed in 2018.

Now they have **32 (in operation) and 7 (under construction)**. + **Overseas**

And they have **overseas projects. (see the next slide)**

Dash for Renewable Comes with New Challenges

- VRE brings challenges to the power sector (generation, system operators, transmission, distribution...)

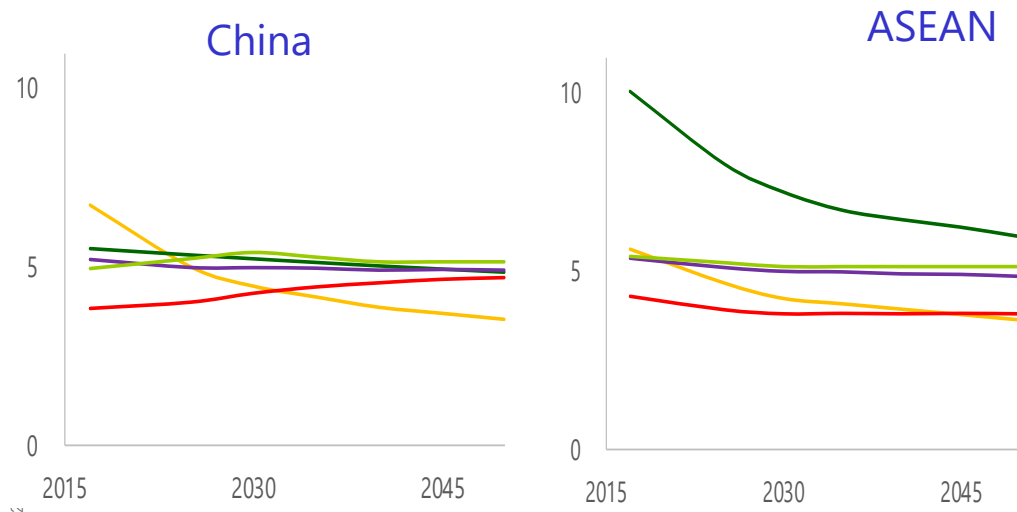
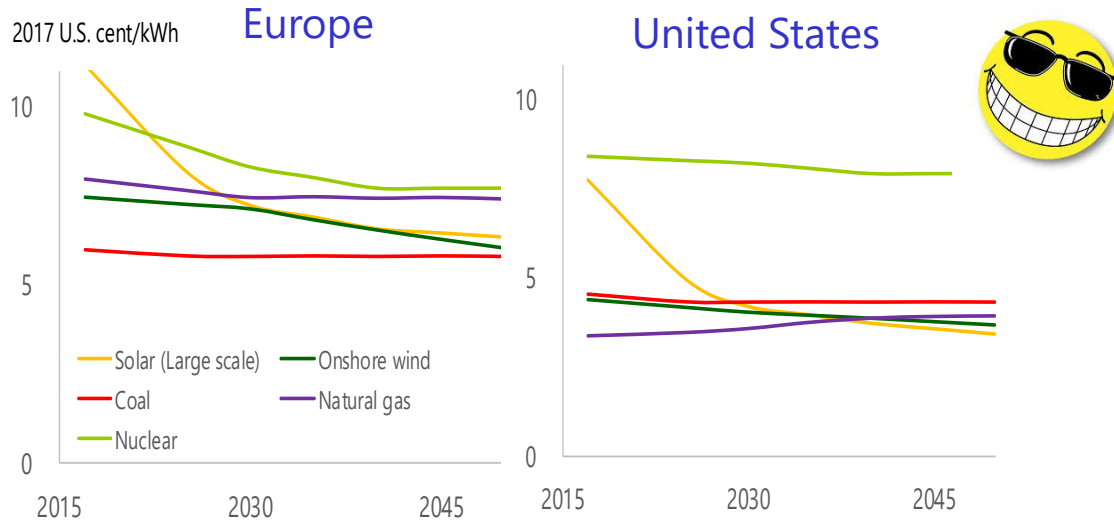
◆ Uncertainty and Intermittency

- ◆ **Low average utilization ratio** (PV:13%, Onshore Wind:20%, Offshore Wind:30%)
 - ➔ More capacity (and space!) required than thermal plants
- ◆ Central grid access may be limited **in peak generation hour** (**curtailment**)
 - ➔ **Flexibility** is required in demand-supply balancing

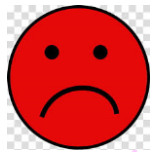
□ All “cons” above mean additional “costs”

Levelized cost of electricity (LCOE) is going down

Source: Estimated by IEEJ



System integration will add costs rapidly



Vertical: Total system cost

Case with a positive carbon price

Optimal

Integration cost (C_{INT})

LCOE: Conventional (C_{conv})

LCOE: VRE (C_{VRE})

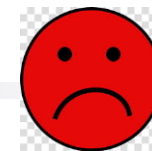
0%

VRE shar in power generation mix

100%

- Levelized Cost of Electricity (LCOE) is a metric that has long been used for assessing the specific cost of power generating facilities.
- The LCOE of VREs has been declining rapidly over decades. By 2050, **the LCOE of solar PV is expected to become lower than that of conventional technologies**, in many region across the world.

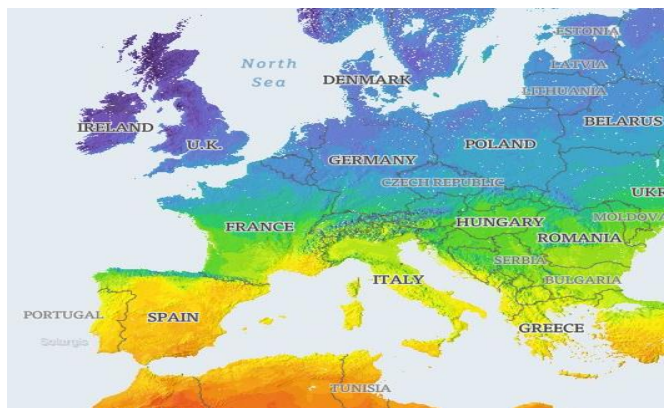
VRE Resources May Not Be Available Everywhere



Solar

Europe

Source:
Global Solar Atlas^{※1}



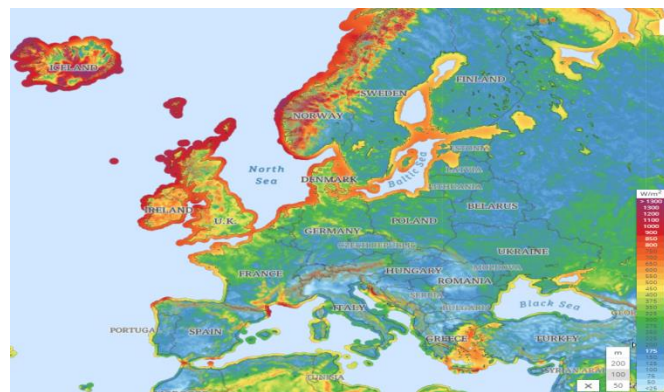
ASEAN



Wind

Europe

Source:
Global Wind Atlas^{※2}



ASEAN



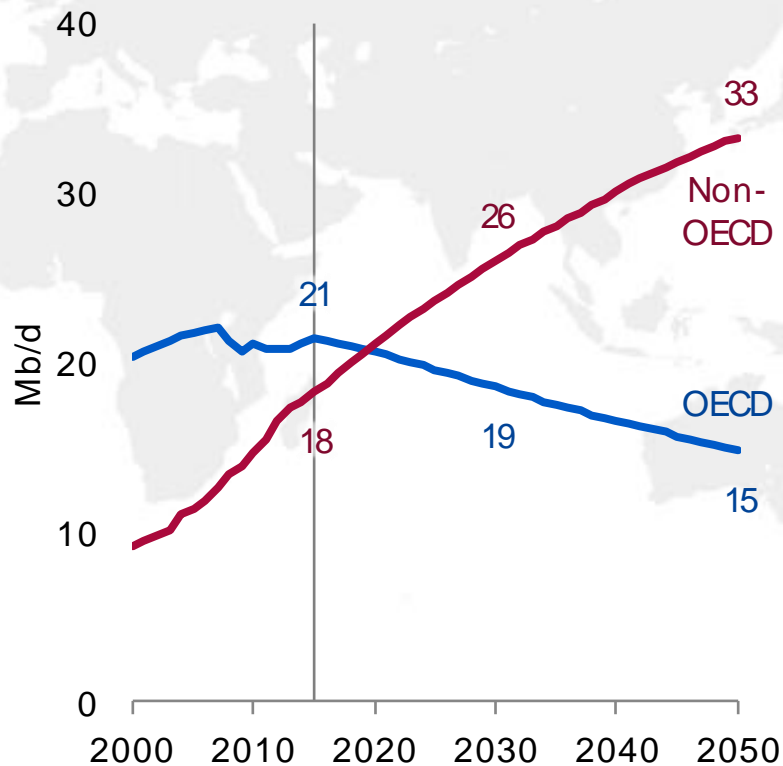
- **VRE resources differ significantly across regions.** While wind power resources are abundant in Europe, ASEAN countries see relatively scarce resources except for those in specific areas in Vietnam and the Philippines.



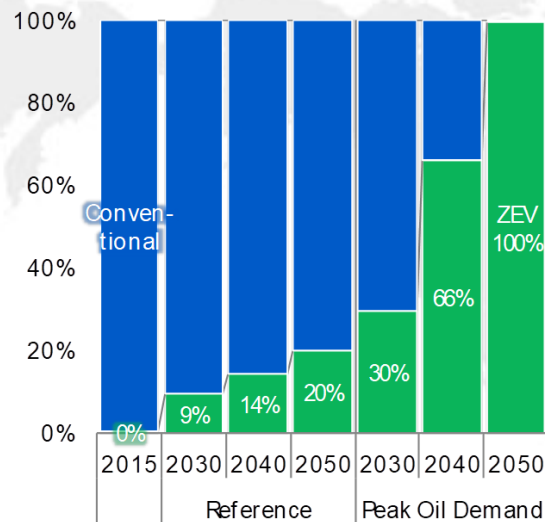
Peak Oil “Demand” Case

from IEEJ’s Outlook 2018

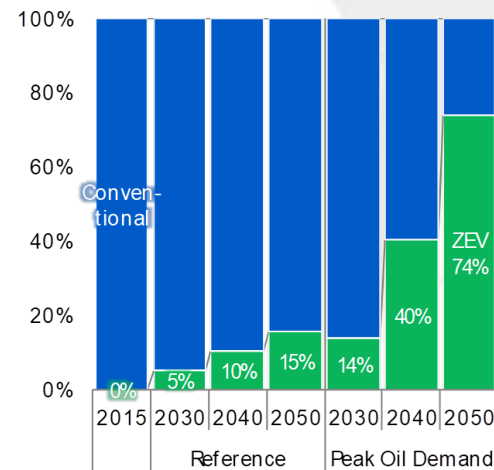
Oil for Road [Reference Scenario]



Assumption of new car sales

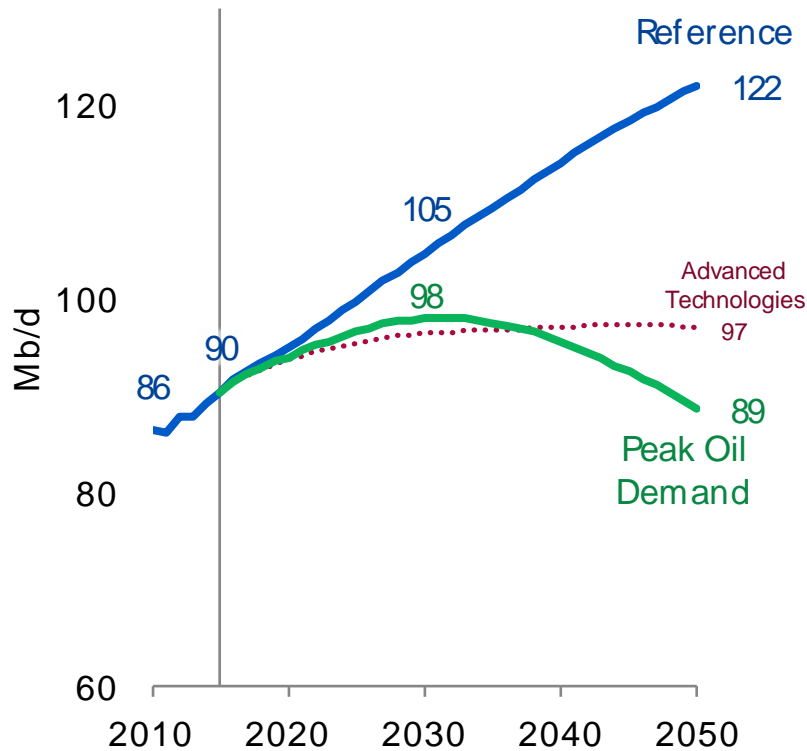


Car On Road

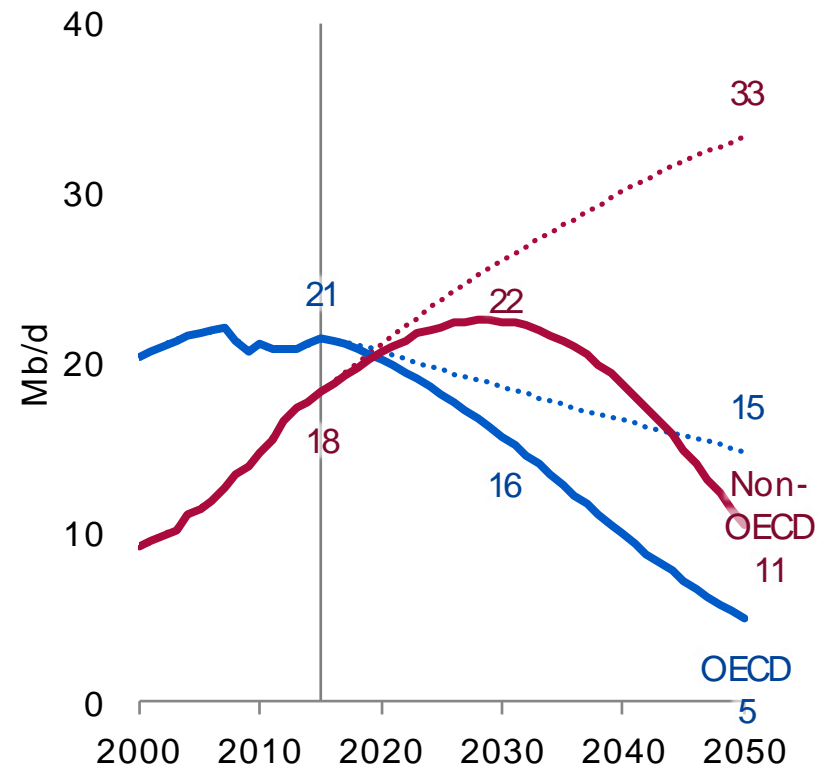


Oil peaks around 2030 with a rapid penetration of ZEVs

Oil consumption



Oil for Road [Peak Oil Demand Case]



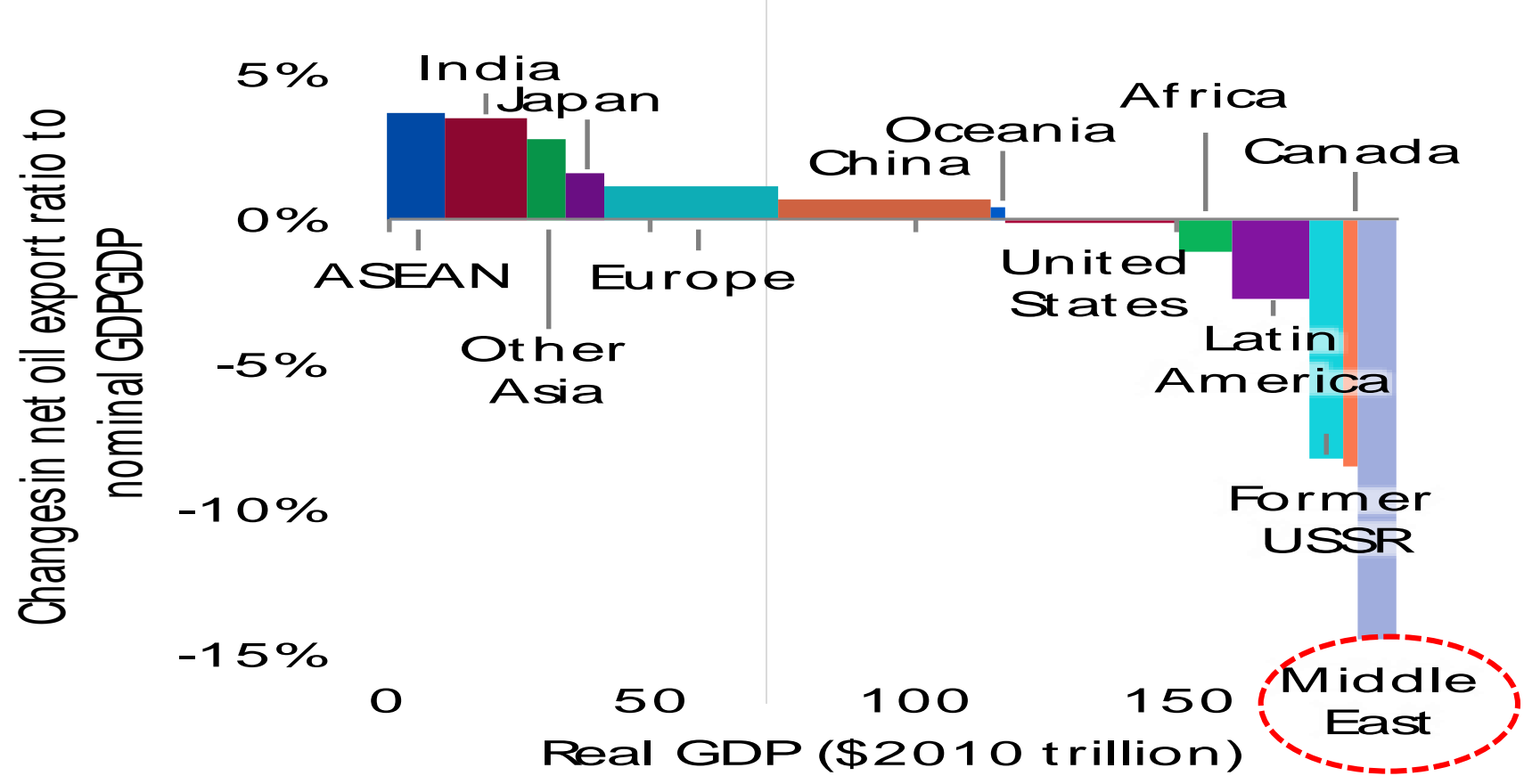
Note: Dotted lines are the Reference Scenario

In the Peak Oil Demand Case, oil consumption hits a peak of 98 Mb/d around 2030 before declining. The reduction from the Reference Scenario is 7 Mb/d and 33 Mb/d in 2030 and in 2050, respectively.

Oil consumption by cars in Non-OECD, which continues to increase rapidly in the Reference Scenario, also declines from around 2030. It is as much as one third of the Reference Scenario in 2050.

...but the economic downturn will affect the Middle East

📊 Changes in net oil exports/imports and ratios to nominal GDP [2050]



Note: Europe excludes the former Soviet Union

How do we recognise the rapid de-oiling?

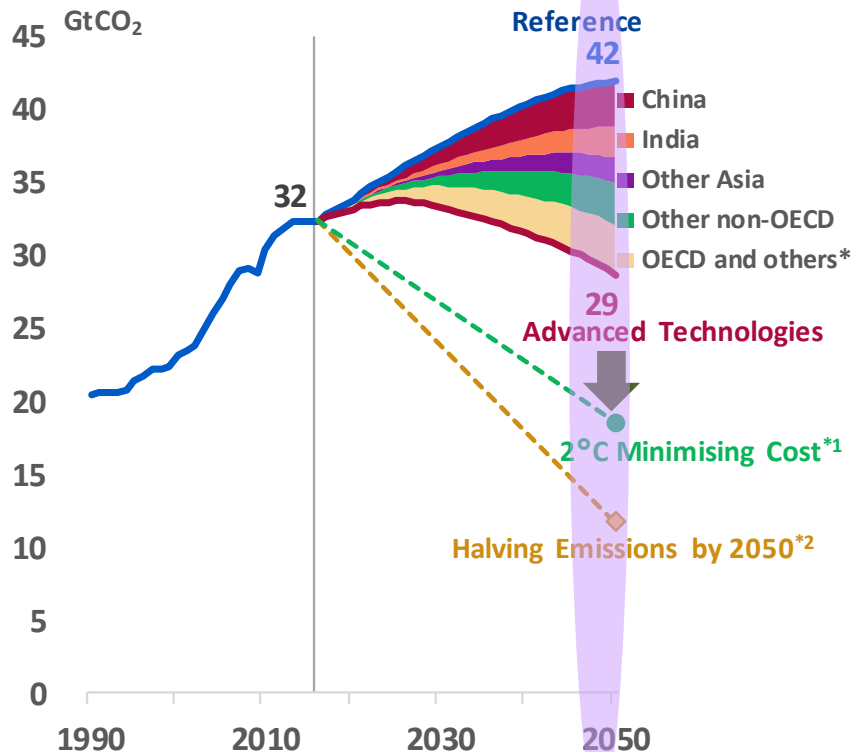
- The **Peak Oil Demand Case** shows that, under some circumstances, **oil consumption can turn into a decline** in the not too distant future.
- However, the feasibility of this Case can be said to be **extremely challenging** because the penetration of ZEVs is far greater than that in the “Advanced Technologies Scenario,” in which a bottom-up approach to the maximum implementation of advanced technologies is adopted. It can be said that **oil consumption may not be so easily reduced, so quickly.**

...and then

- It should not be overlooked that in the Peak Oil Demand Case, **oil remains required in 2050 on a scale that does not differ from today.**
- **If the supply investment becomes insufficient** due to excessive pessimism in the future, it can trigger the switching from oil to other energies **threatening energy security.**
- The **rising dependence on the Middle East** crude oil will increase **geopolitical risk** for stable supply.
- Although it is reasonable to expect that Governments in the Middle East would cut public investment and subsidies to reduce budget deficits while coping with low oil prices, it is difficult to deny the possibility of increasing social anxiety and of a worsening situation in the region.
- The role of consuming countries as well as producing countries' own efforts continue to be important. Support to the efforts represented by Saudi Arabia “Saudi Vision 2030” is needed.

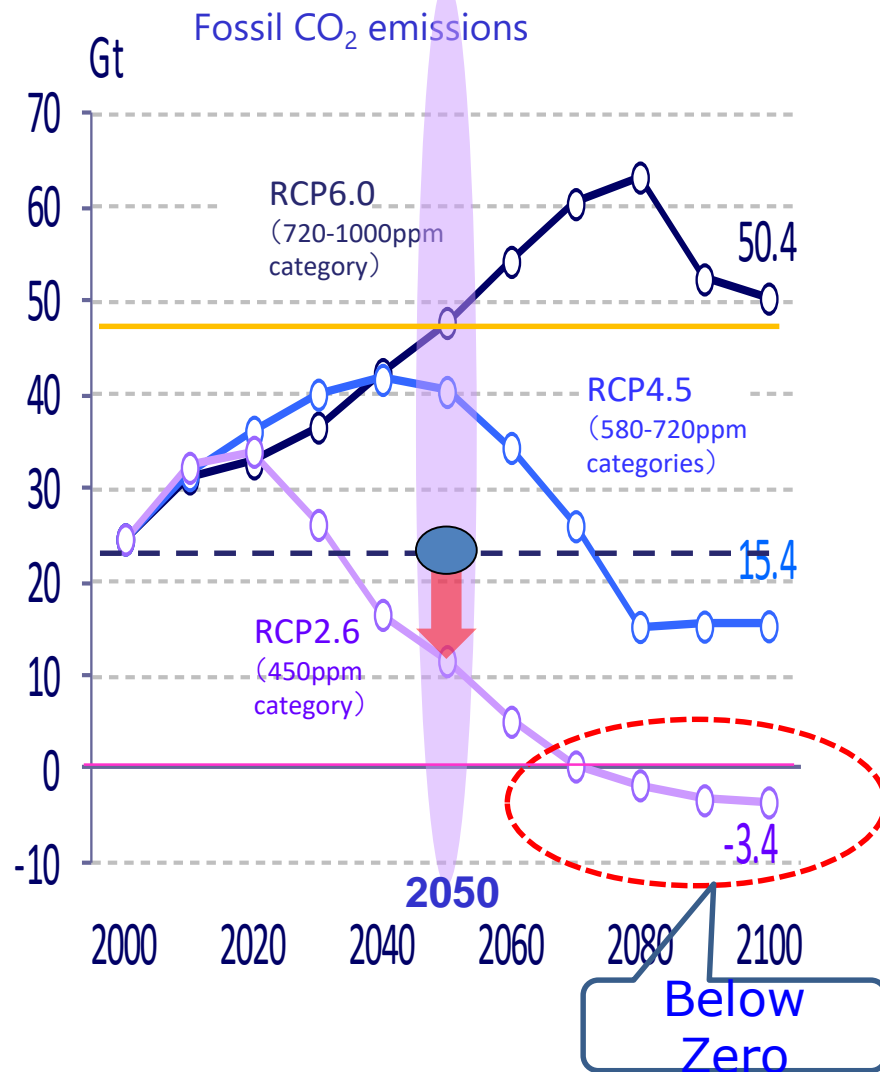
Net Zero Emission by 2070 (5th IPCC report)

❖ Energy-related CO₂ emissions



* Includes international bunkers.

*1 Refer "IEEJ Outlook 2018". *2 This path represents an emission path in the RCP2.6 scenario summarised in the fifth Assessment Report by IPCC.



※ Calculated using MAGICC 6.0

Meinshausen, M., S. C. B. Raper and T. M. L. Wigley (2011). "Emulating coupled atmosphere-ocean and carbon cycle models with a simpler model, MAGICC6: Part I – Model Description and Calibration." Atmospheric Chemistry and Physics 11: 1417-1456.

New Players:

3Ds and Carbon-Free H₂ in rescue

- **Distributed** or small-scale regional energy network in addition to existing central network (+decentralization)
- **Digitalisation** and IT, IoT assist balancing demand and supply as well as clearing the markets with new players (+digitization)
- **Democratized** energy system allows, on a small-scale, prosumers and VPPs (virtual power plants) to join the electrification with clean electricity
- On a larger scale, the availability of **carbon-free H₂** (either from hydrocarbon + CCS or renewables) is another option as well as **carbon recycle** and **CCUS**

- **Decarbonization push** led by the EU and financial sector induces drastic shift towards cleaner energy use and **energy transformation** with challenges yet to be tackled. Nuclear is also a clean energy option but higher costs make it increasingly challenging for OECD countries.
- **Growing Asia** faces different challenges in energy use such as air pollution, increasing import dependence, energy access, **sustainability** and concern for **energy security**.
- Energy Transformation means paradigm shift which requires different thinking and systems such as: central system → **distributed system**
- More renewable (**and nuclear**), **innovation**, investment, market reforms, energy security, sustainable growth, affordable energy
→ require national leadership, new business models and PA

Collaborations for technology innovation, cost reduction, rule making and competitive market development are essential

Thank you for your attention!



For more advanced analyses, please contact IEEJ at otoiawase@tky.iej.or.jp