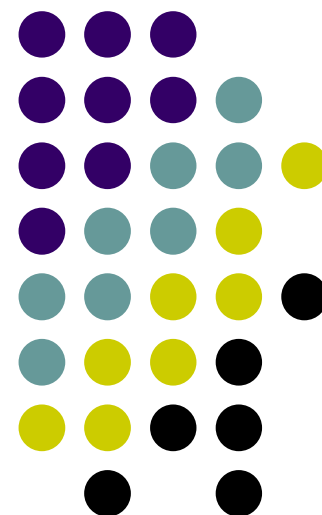


# from GHGs stabilization toward zero-emission

Yoshikatsu Yoshida  
Central Research Institute of  
Electric Power Industry



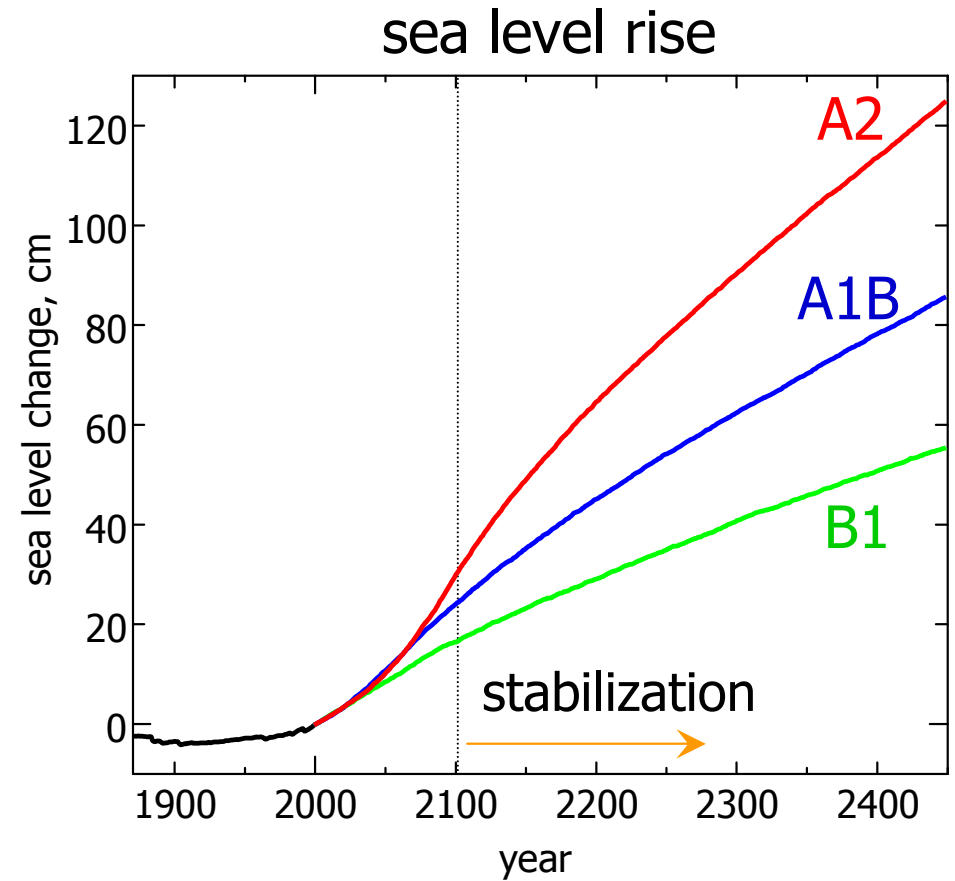
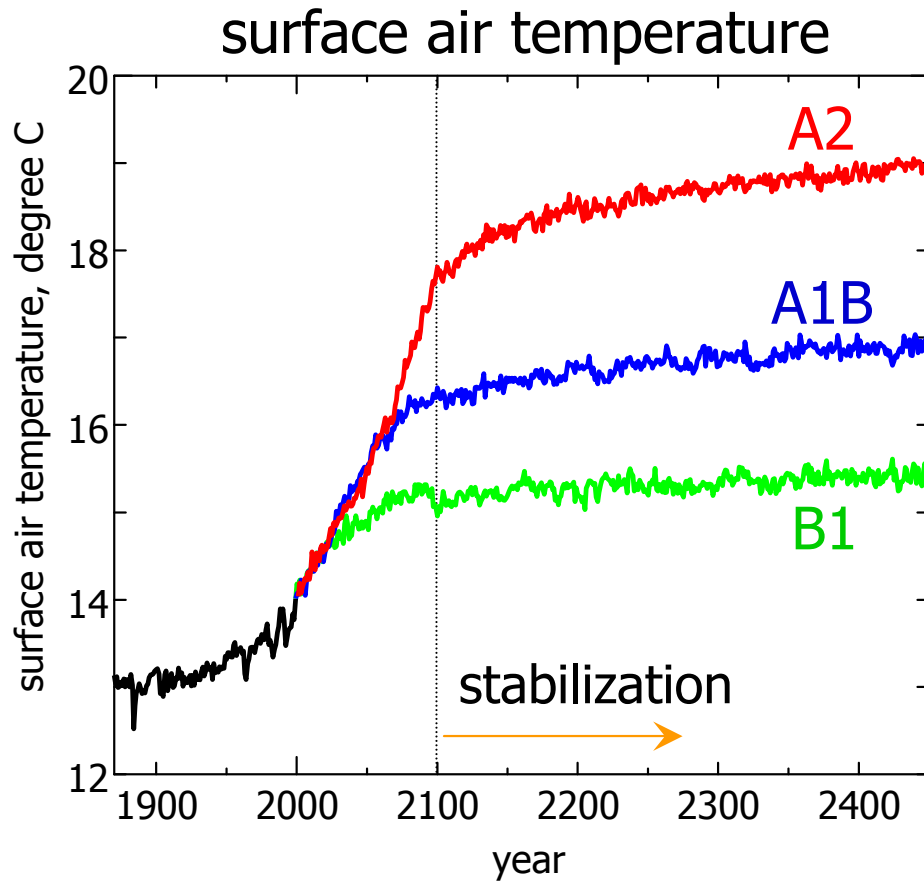
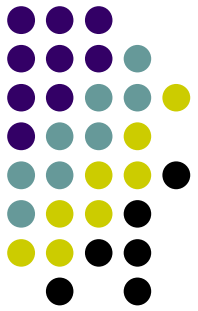
# GHGs stabilization



- UN Framework Convention on Climate Change
  - Article 2: Objective

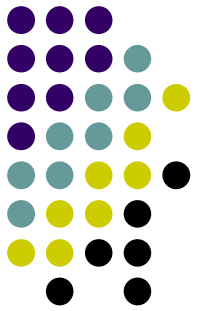
The **ultimate objective** of this Convention and any related legal instruments that the Conference of the Parties may adopt **is to achieve**, in accordance with the relevant provisions of the Convention, **stabilization of greenhouse gas concentrations in the atmosphere** at a level that would prevent **dangerous anthropogenic interference with the climate system.**

# Long-lasting warming and sea level rise



IPCC WG1/AR4 SPM: Anthropogenic warming and sea level rise would continue for centuries, even if GHG concentrations were to be stabilized.

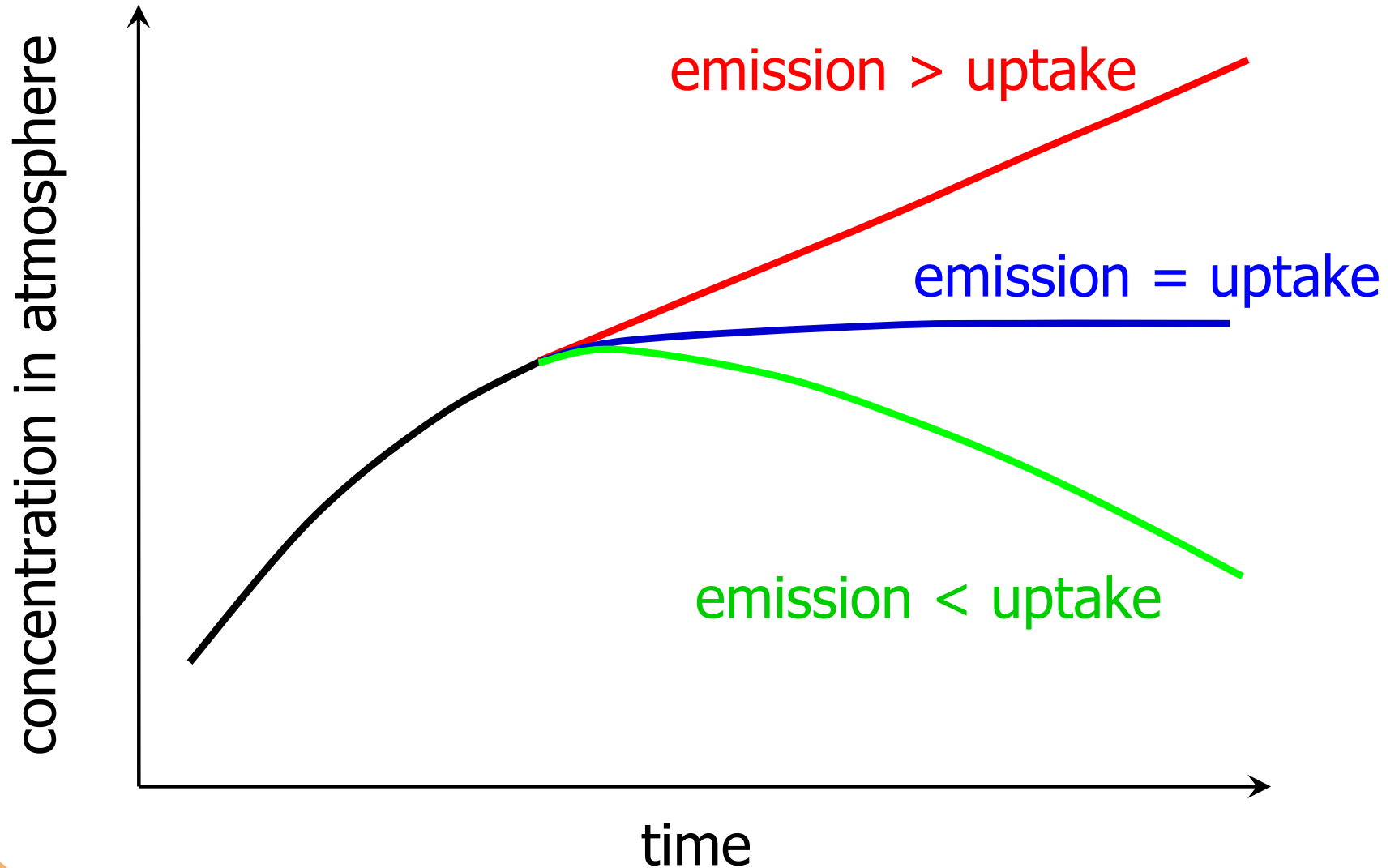
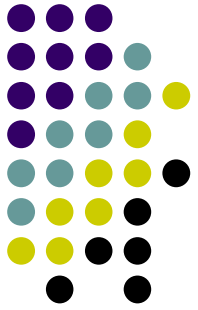
# Melting of Greenland Ice Sheet



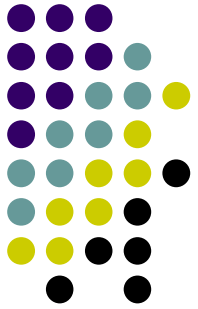
Current models suggest that the surface mass balance of the Greenland Ice Sheet becomes negative at a global average warming in excess of 1.9 to 4.6 centigrade. If a negative surface mass balance were sustained for millennia, that would lead to virtually complete elimination and a resulting contribution to sea level rise of about 7 m.



# CO<sub>2</sub> emission vs. CO<sub>2</sub> uptake

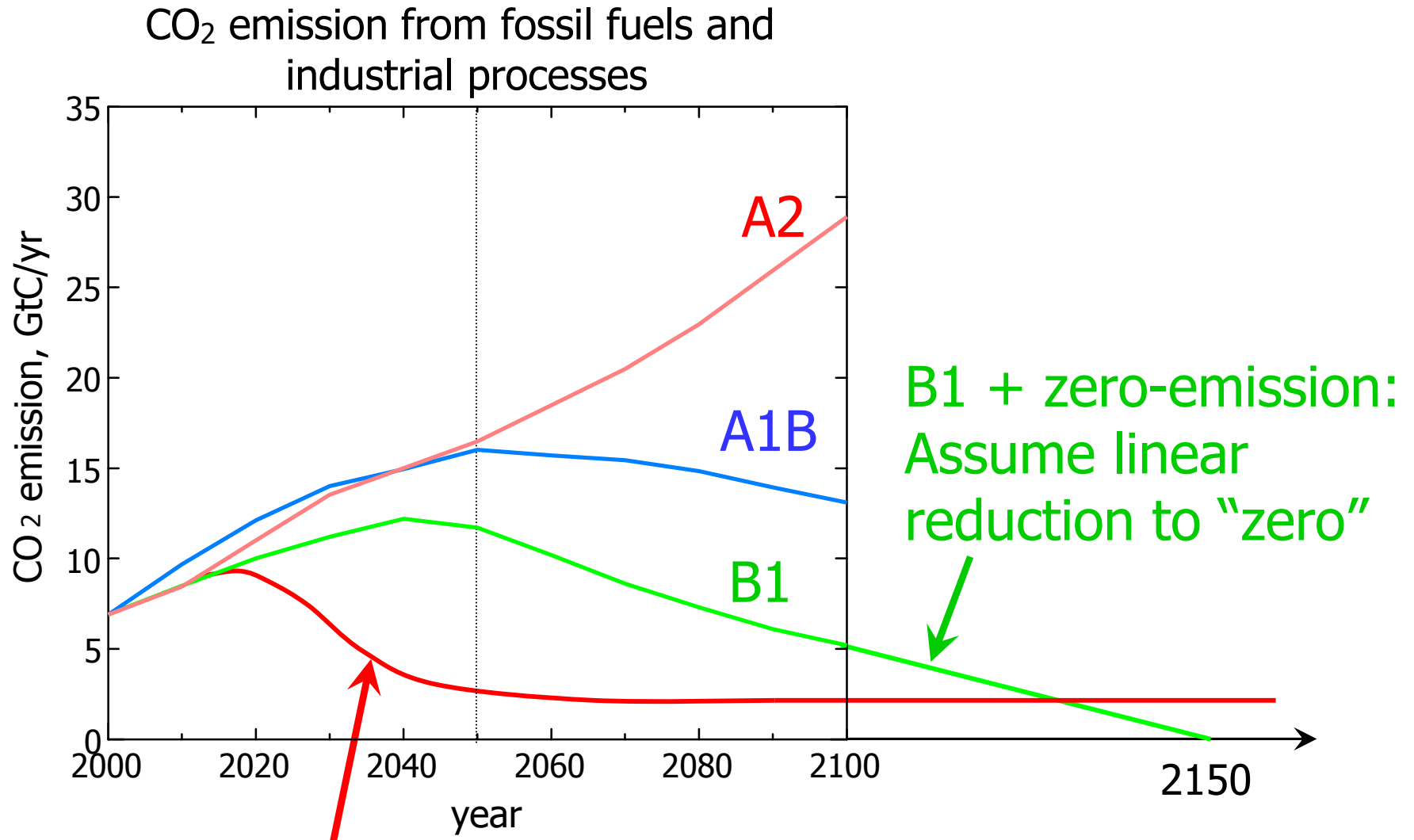
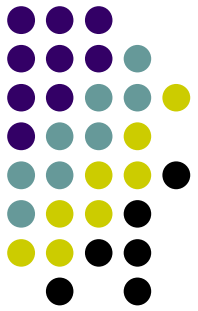


# Strategy



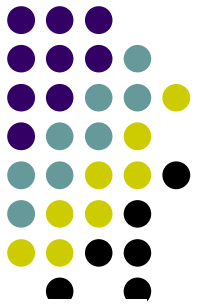
- The first step is to **stabilize GHG concentrations** in atmosphere; **emission = uptake**. (UNFCCC Article 2)
- Continue further reduction of GHG emissions; **emission < uptake**. Final target is **“zero-emission”** throughout the world.
  - ✓ lower the GHG concentrations in atmosphere
  - ✓ long-lasting surface warming and sea level rise could be resolved.
- Note
  - ✓ needs **“adaptation”** measures against climate change

# An example pathway to zero-emission



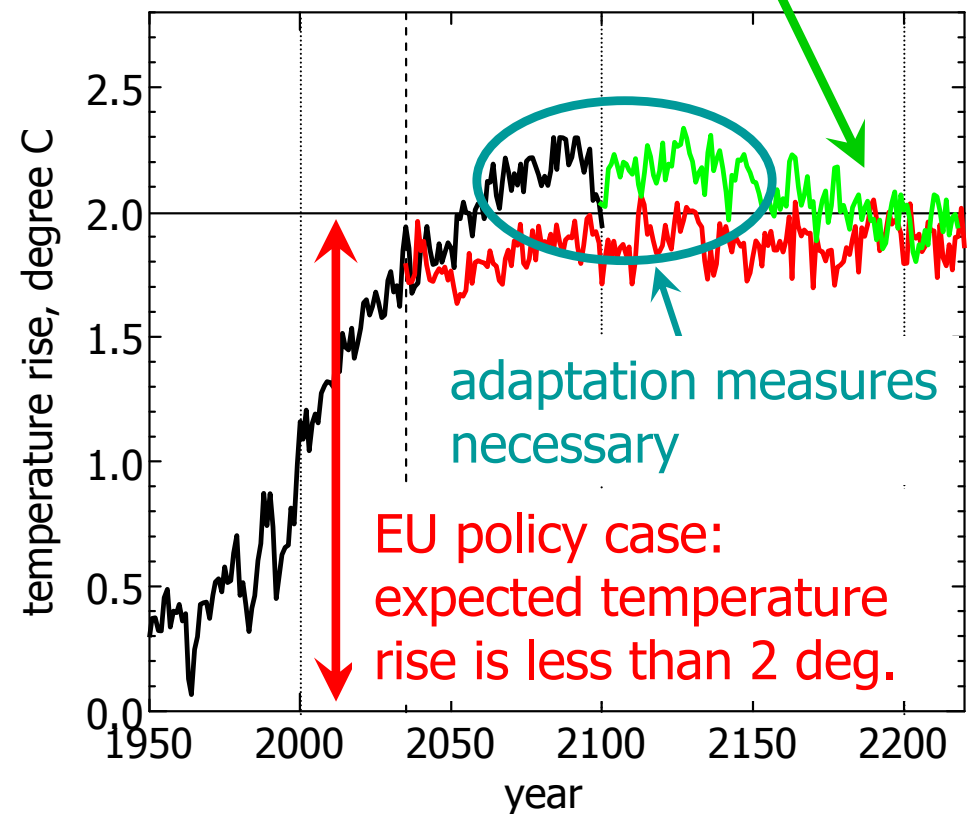
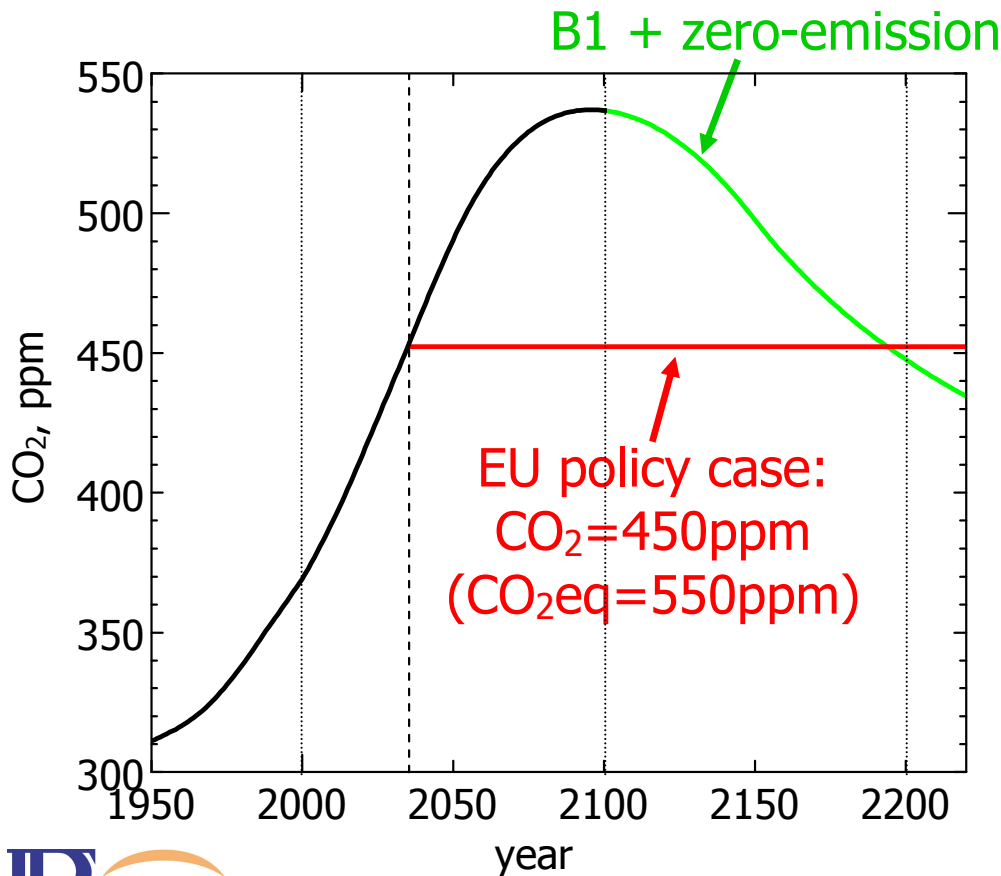
EU policy: Halve CO<sub>2</sub> emission in 2050

# Numerical experiment demonstrates recovery of climate



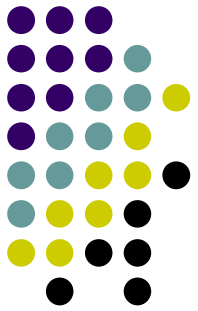
“B1 + zero-emission” case:

Temperature decreases gradually after 2100. Then, temperature rise since pre-industrial possibly falls below 2 degree around 2200.

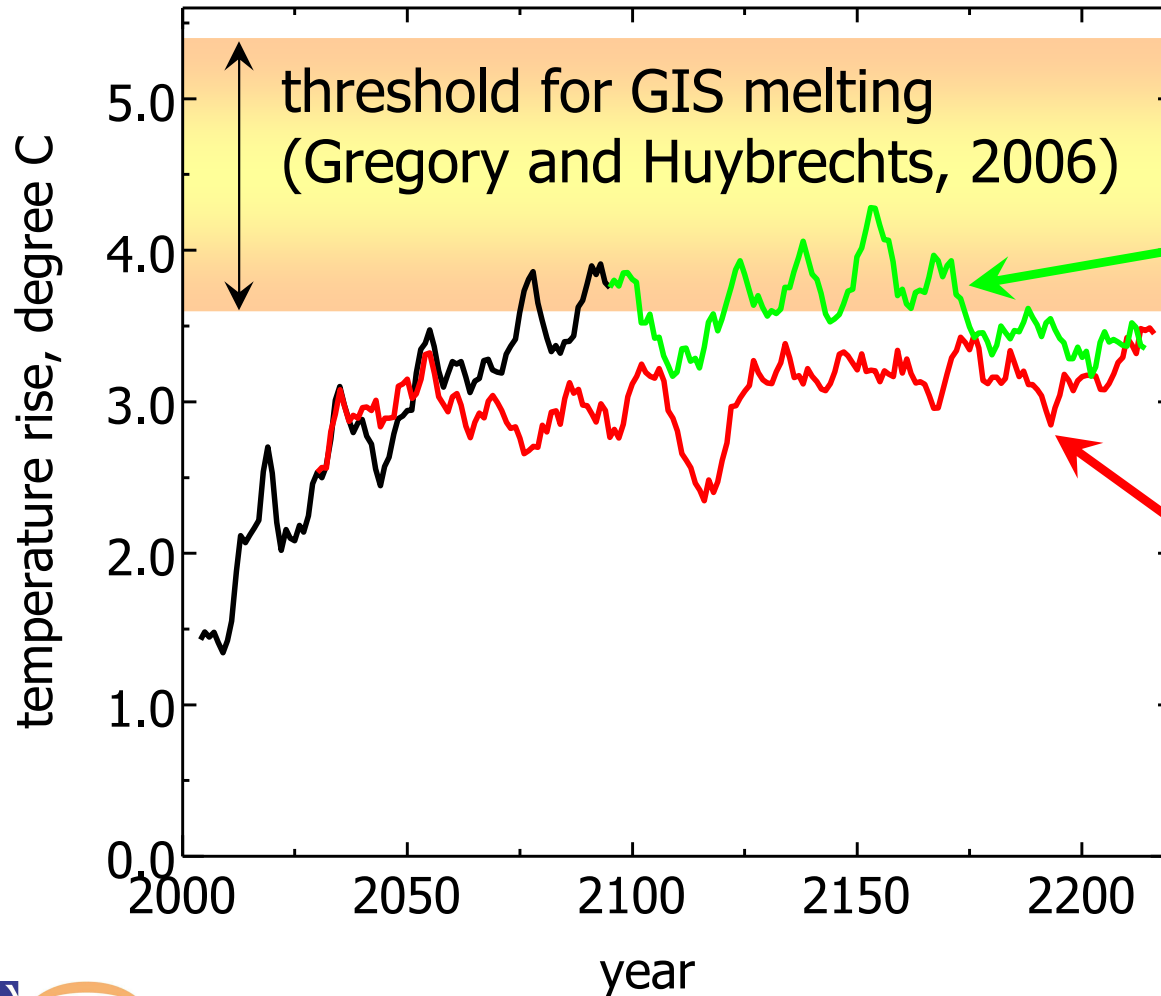




# Will GIS melting take place in future?



temperature over Greenland



"B1 + zero-emission" :  
exceeds lower limit of  
threshold for 100 years,  
then, recovers below  
threshold

EU policy case:  
temperature over Greenland  
sustained below threshold

# Technologies could realize zero-emission world



Technology transfer to Asian countries

**Japan**

Energy saving, high-efficiency

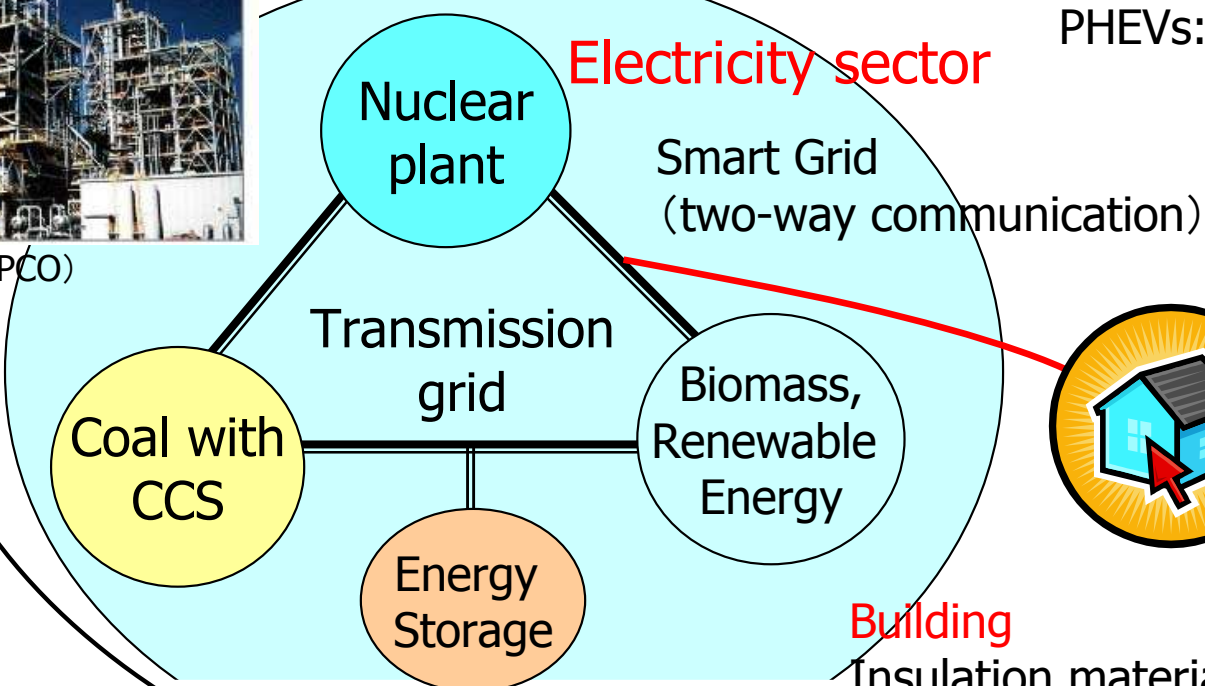
IGCC system

石炭ガス化複合発電パイロットプラント  
(需給共同火力(株)勿来発電所構内)



(Source: TEPCO)

**Electricity sector**



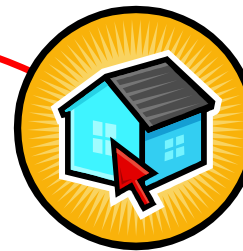
Energy Supply system w/ zero-emission

**Transportation**

PHEVs: Plug-in Hybrid Electric Vehicles



(Source: Toyota)



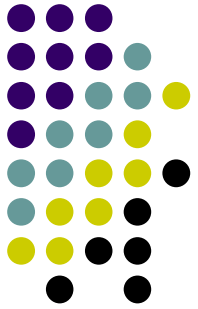
**Home**

- Smart meter
- Heat pump
- IH cooking tool

**Building**

- Insulation materials
- Smart meter
- Cooling system

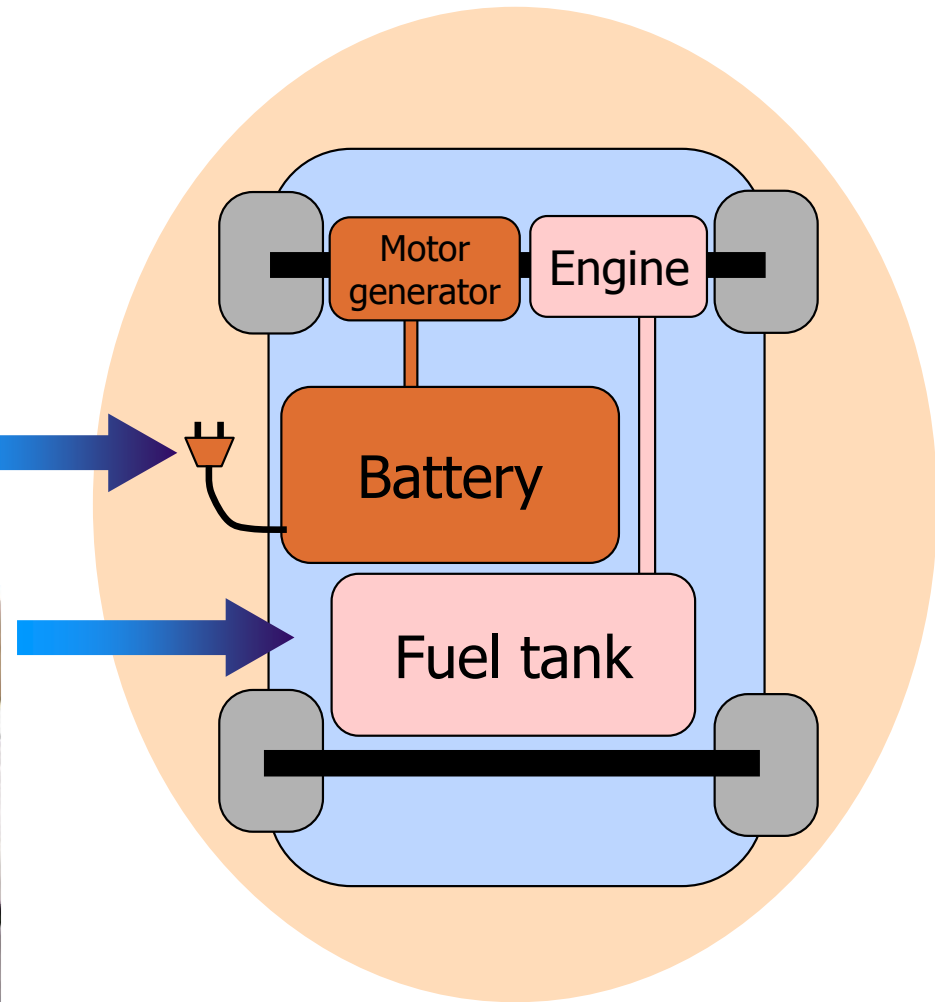
# What is Plug-in Hybrid Electric Vehicle



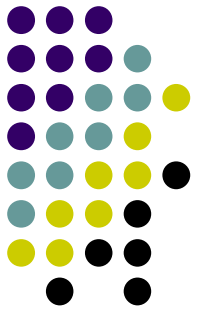
Electricity



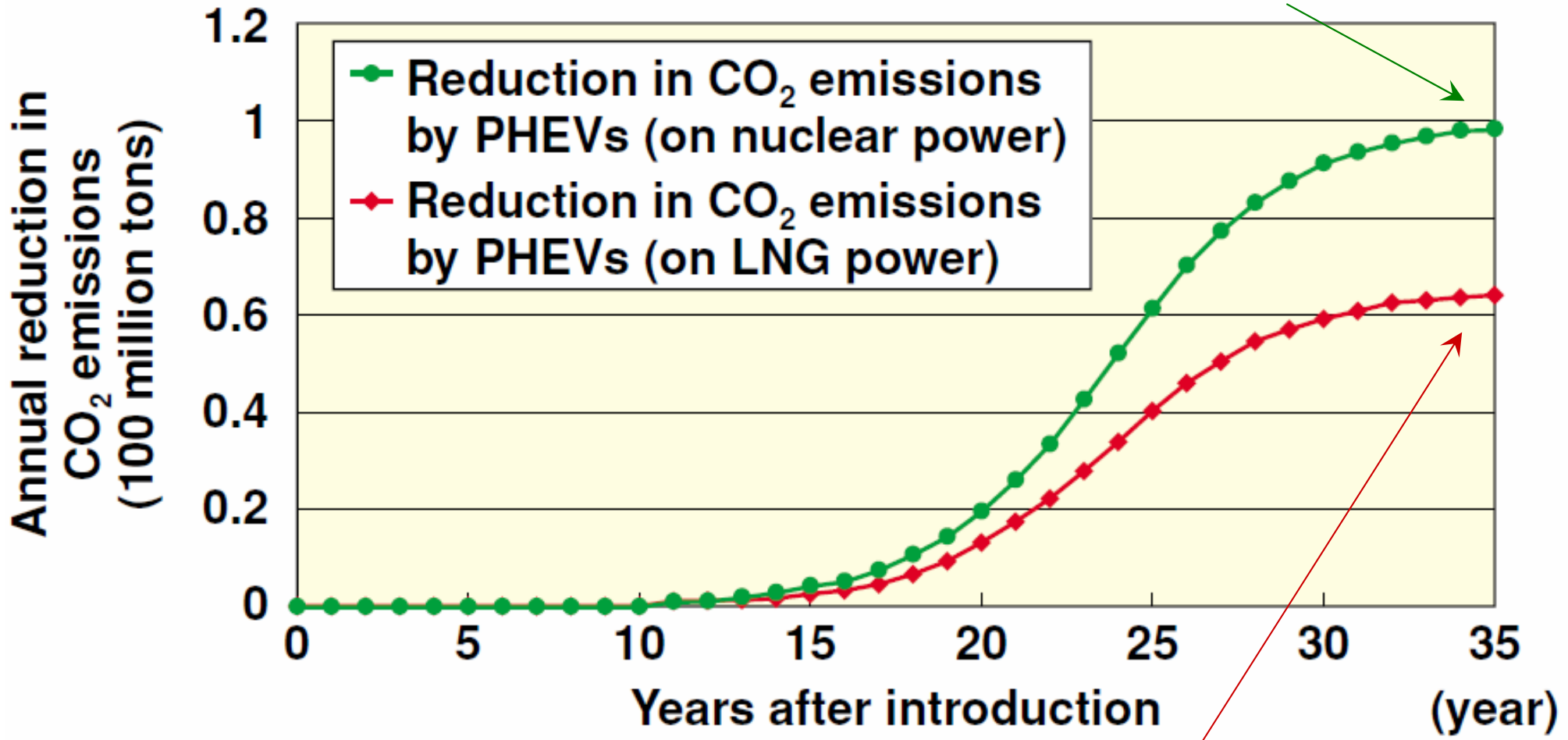
Gasoline



# PHEV's potential for CO<sub>2</sub> emission reduction in Japan

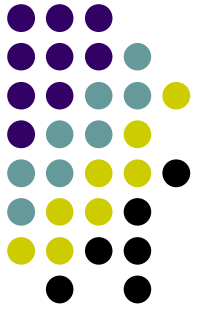


38% of total emission from transportation sector in 2000



23% of total emission from transportation sector in 2000

# Summary



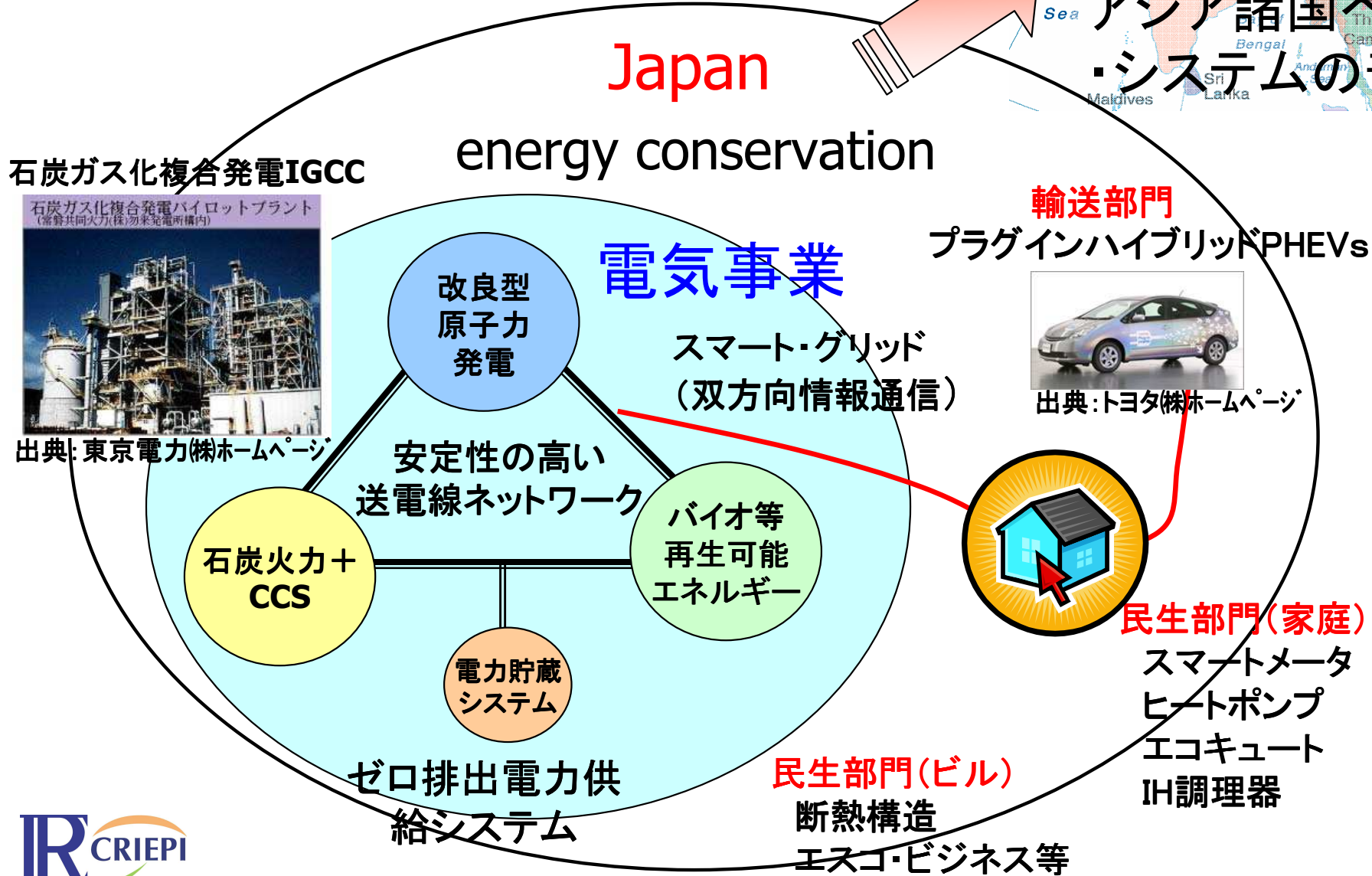
- **GHGs stabilization is not enough** to prevent dangerous anthropogenic interference w/ climate system. Have to proceed to **“zero-emission”**.
- Key technologies are
  - ✓ **IGCC coal fired plants w/ CCS**
  - ✓ **Biomass** and other renewable energies
  - ✓ Plug-in hybrid electric vehicles
  - ✓ others
- **Scenario study for “zero-emission”**



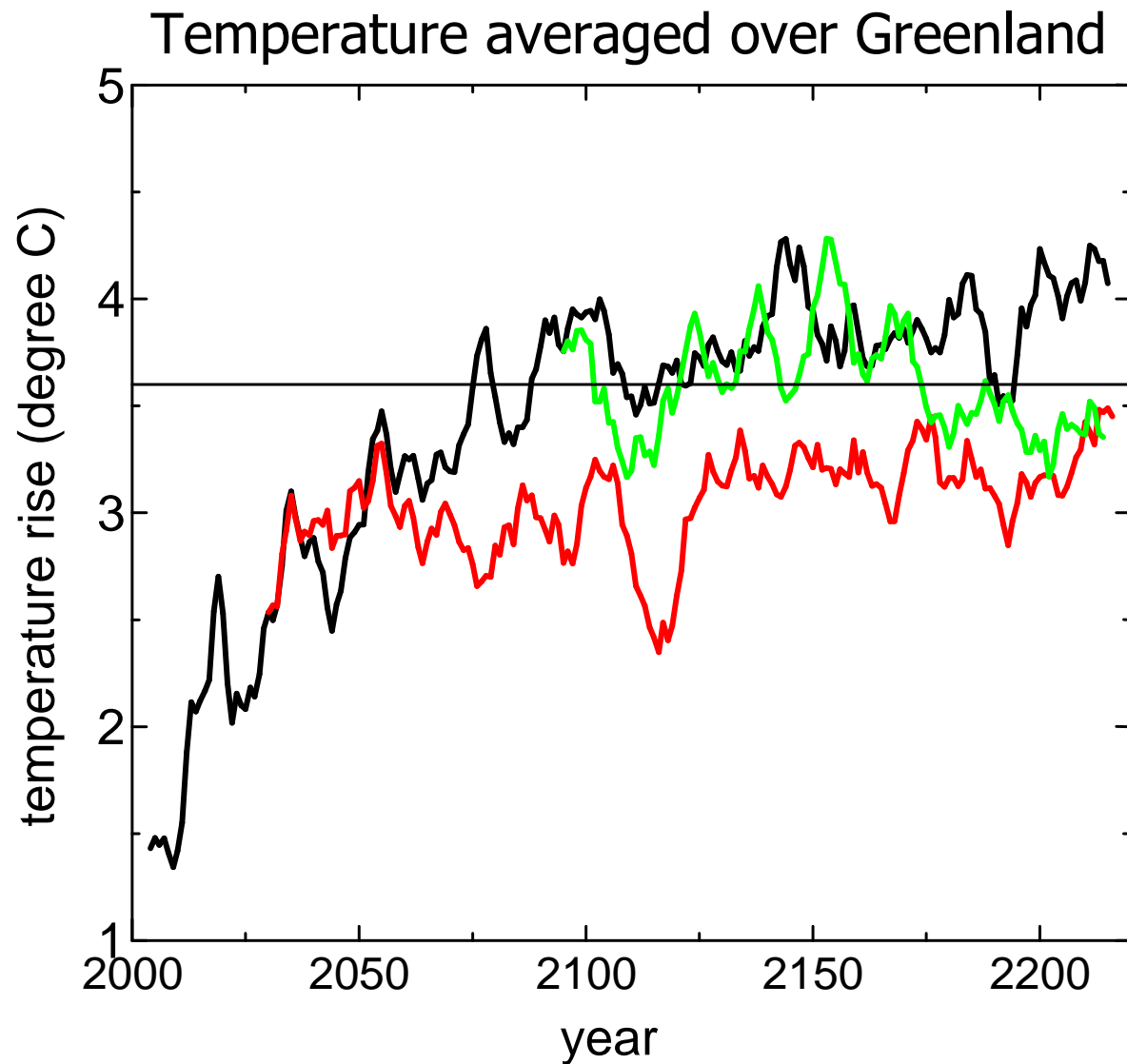
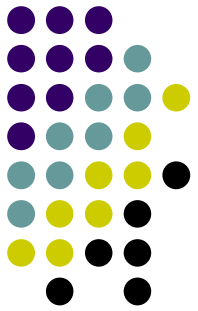
# How to achieve zero-emission world



アジア諸国への技術・システムの普及



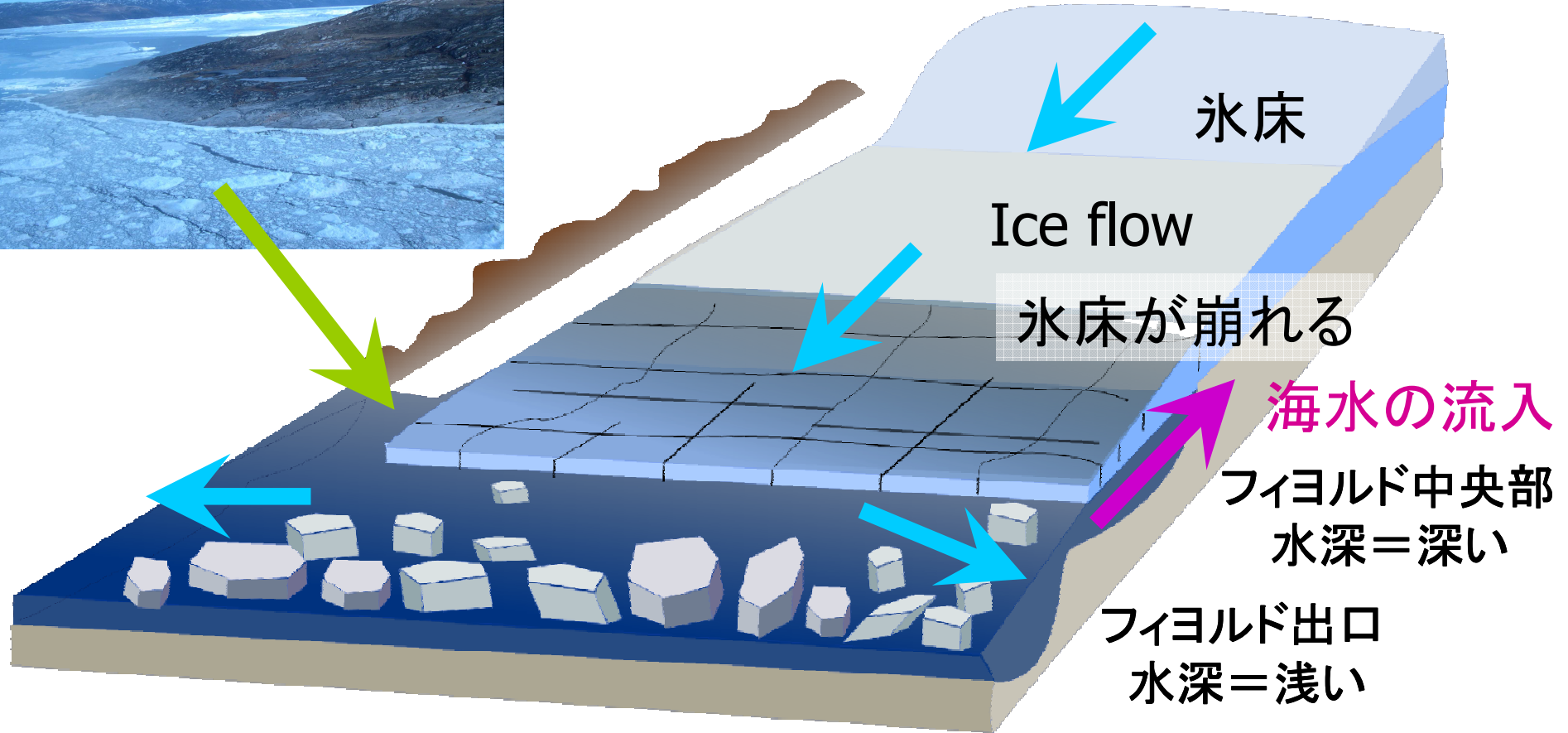
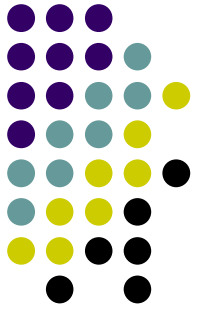
# Numerical experiment (2)





# Summary of future projections

アイスフィヨルドのIce flowの速度は過去10年で2倍に増加(観測)。



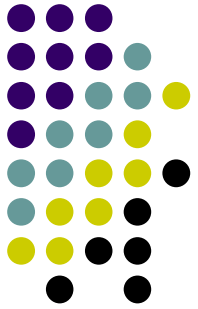
氷山が座礁し、Ice flowの速度を抑えている。温暖化でIce flowの速度が増加すると、海面上昇が加速する。

# Summary of future projections



	Temperature change (degree C at 2090-2099 relative to 1980-1999)		Sea level rise (m at 2090-2099 relative to 1980-1999)
	best estimate	likely range	
B1 scenario	1.8	1.1 ~ 2.9	0.18 ~ 0.38
A1T scenario	2.4	1.4 ~ 3.8	0.20 ~ 0.45
B2 scenario	2.4	1.4 ~ 3.8	0.20 ~ 0.43
A1B scenario	2.8	1.7 ~ 4.4	0.21 ~ 0.48
A2 scenario	3.4	2.0 ~ 5.4	0.23 ~ 0.51
A1FI scenario	4.0	2.4 ~ 6.4	0.26 ~ 0.59


# GHGs stabilization



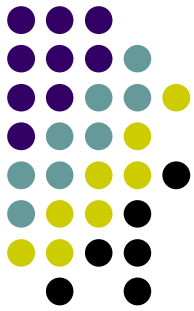
- UNFCCC Article 2
  - The **ultimate objective** of this Convention is to achieve **stabilization of greenhouse gas concentrations** in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
  - Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

# Summary of future projections



- まず、CO<sub>2</sub>等の温室効果ガス（GHGs）濃度の安定化を目指す（国連条約第2条）
- さらに、**削減**を継続し、地球の吸収量以下に排出量を抑制し、最終的には世界全体でゼロ排出世界を目指し、グリーンランド氷床融解等の危険な影響の回避を目指す
- 一方で、GHGsの削減効果が現れるには、長期間を有するため、不可避的な気候変化に対し  
 **て適応策**を講ずる

# GHGs stabilization and response



## CO<sub>2</sub> concentration, temperature, and sea level continue to rise long after emissions are reduced

Magnitude of response

Time taken to reach equilibrium

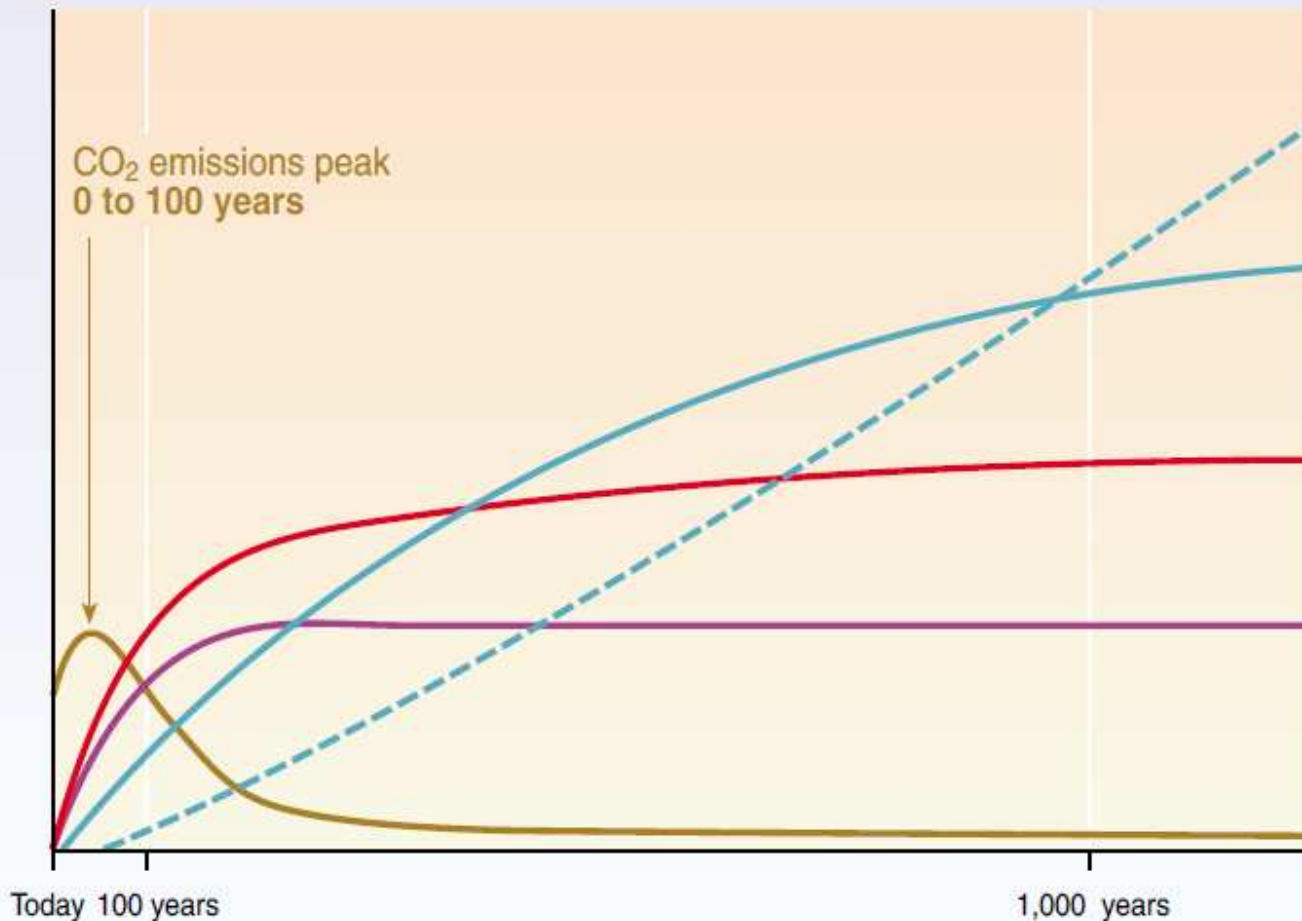
Sea-level rise due to ice melting:  
several millennia

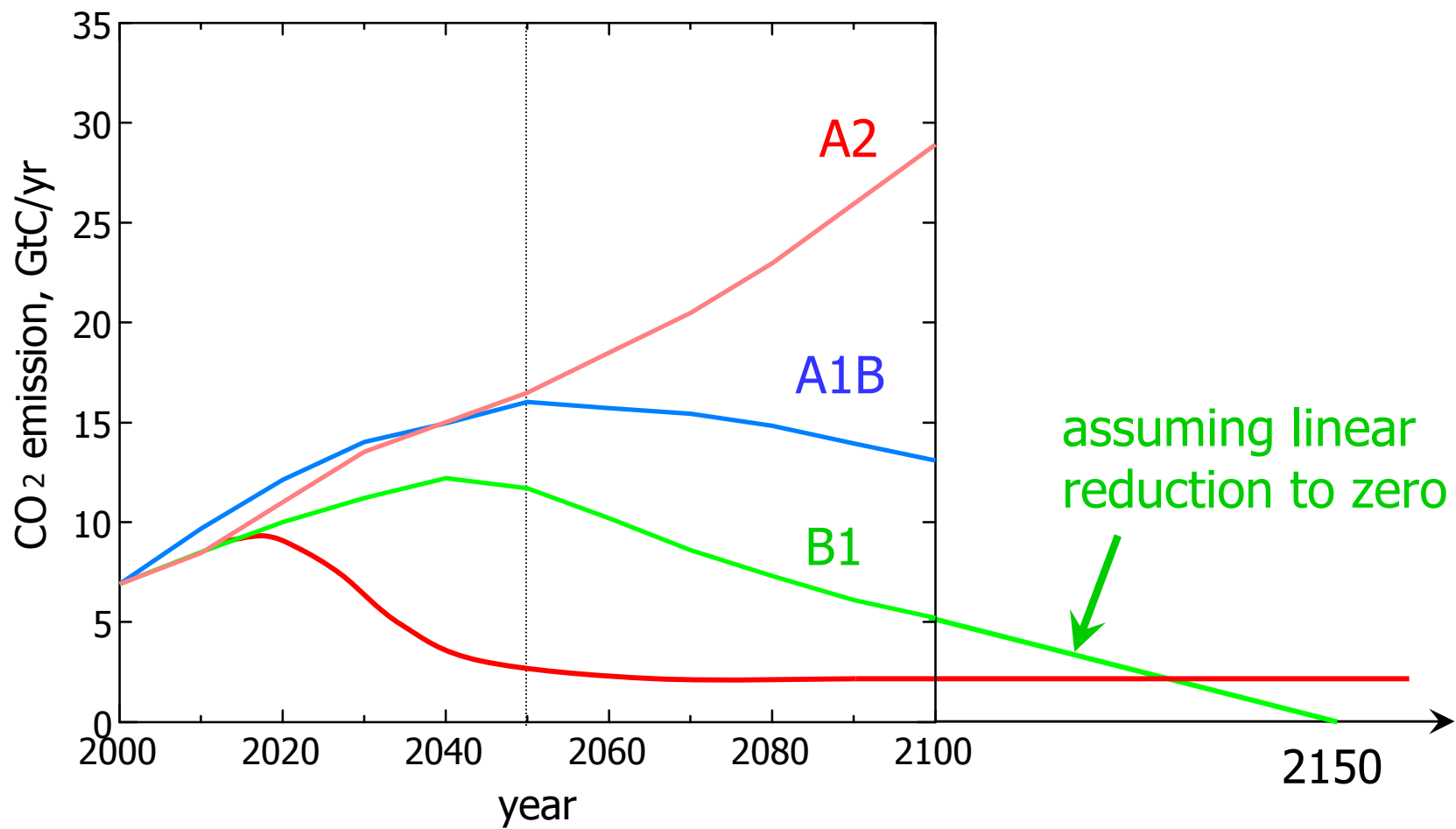
Sea-level rise due to thermal expansion:  
centuries to millennia

Temperature stabilization:  
a few centuries

CO<sub>2</sub> stabilization:  
100 to 300 years

CO<sub>2</sub> emissions





EU削減(2050年で半減)



# 世界全体のゼロ排出は夢ではない(今後の課題)



アジア諸国への技術・システムの普及

日本

省エネ、効率向上

石炭ガス化複合発電IGCC

石炭ガス化複合発電パイロットプラント  
(常磐共同火力(株)勿来発電所構内)



出典: 東京電力(株)ホームページ

改良型  
原子力  
発電

電気事業

スマート・グリッド  
(双方向情報通信)

安定性の高い  
送電線ネットワーク

石炭火力+  
CCS

バイオ等  
再生可能  
エネルギー

電力貯蔵  
システム

ゼロ排出電力供  
給システム

輸送部門

プラグインハイブリッドPHEVs



出典: トヨタ(株)ホームページ

民生部門(家庭)

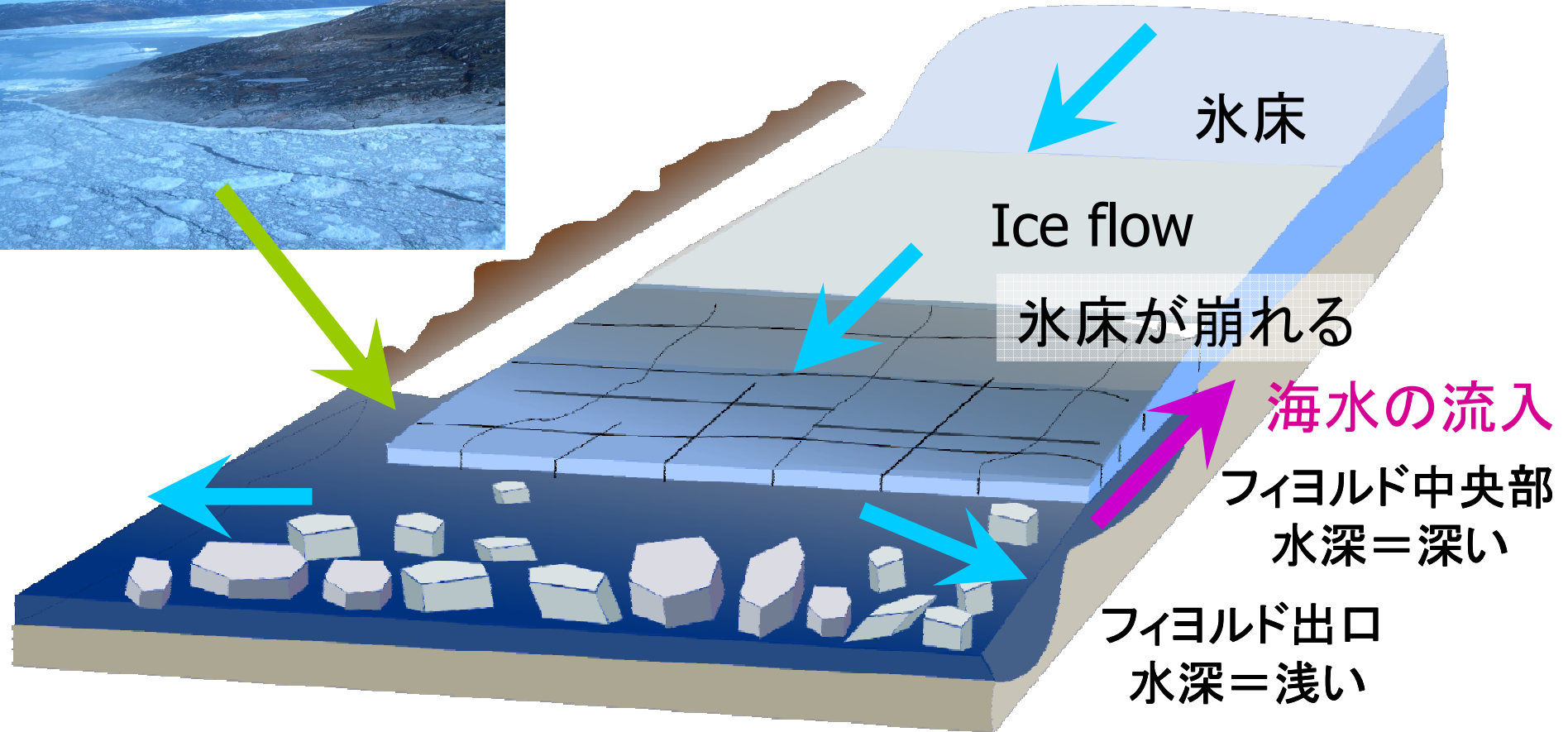
スマートメータ  
ヒートポンプ  
エコキュート  
IH調理器

民生部門(ビル)

断熱構造  
エスゴ・ビジネス等

# 削減目標では、グリーンランド氷床融解の回避が重要

アイスフィヨルドのIce flowの速度は過去10年で2倍に増加(観測)。

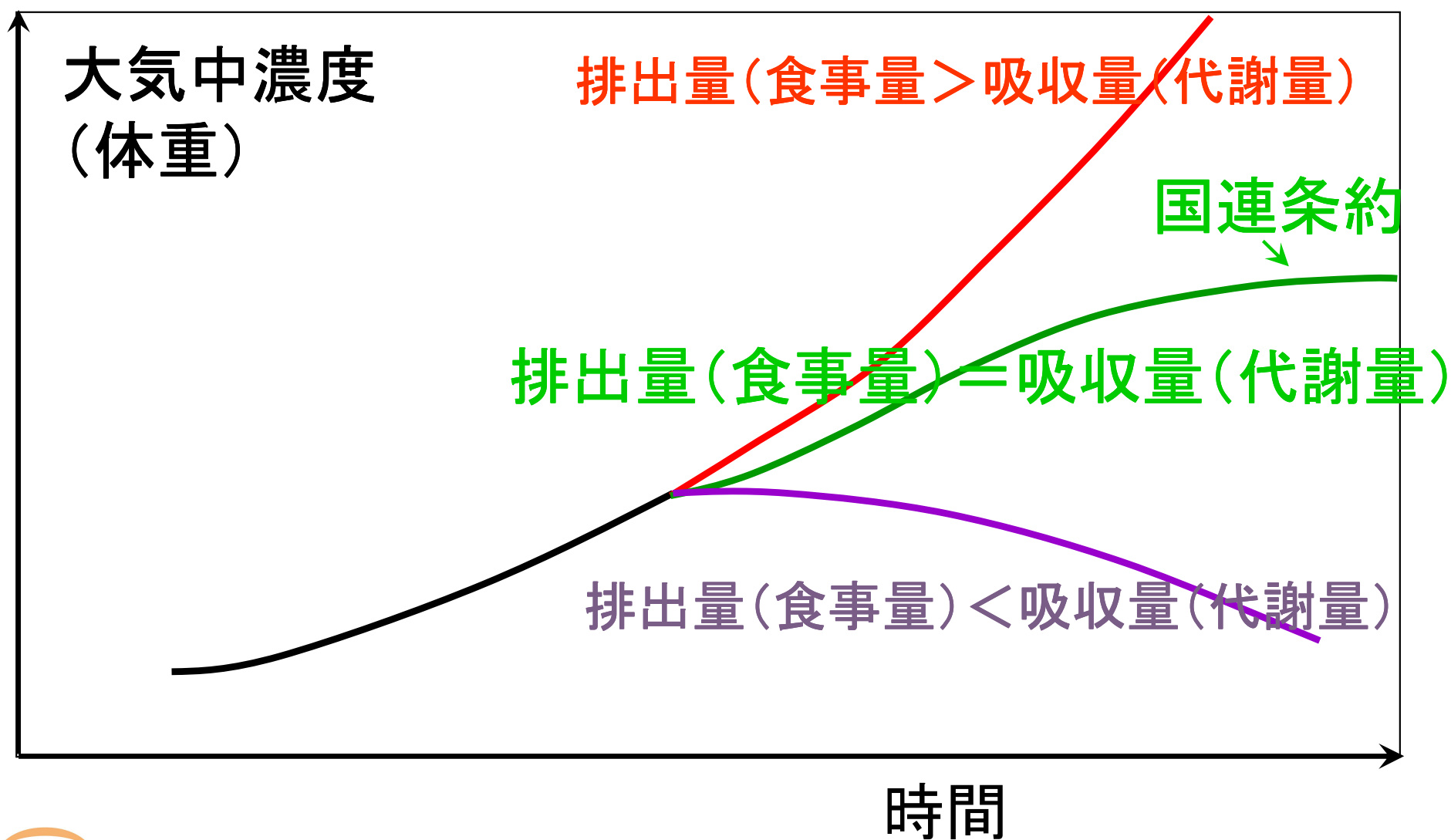


氷山が座礁し、Ice flowの速度を抑えている。温暖化でIce flowの速度が増加すると、海面上昇が加速する。

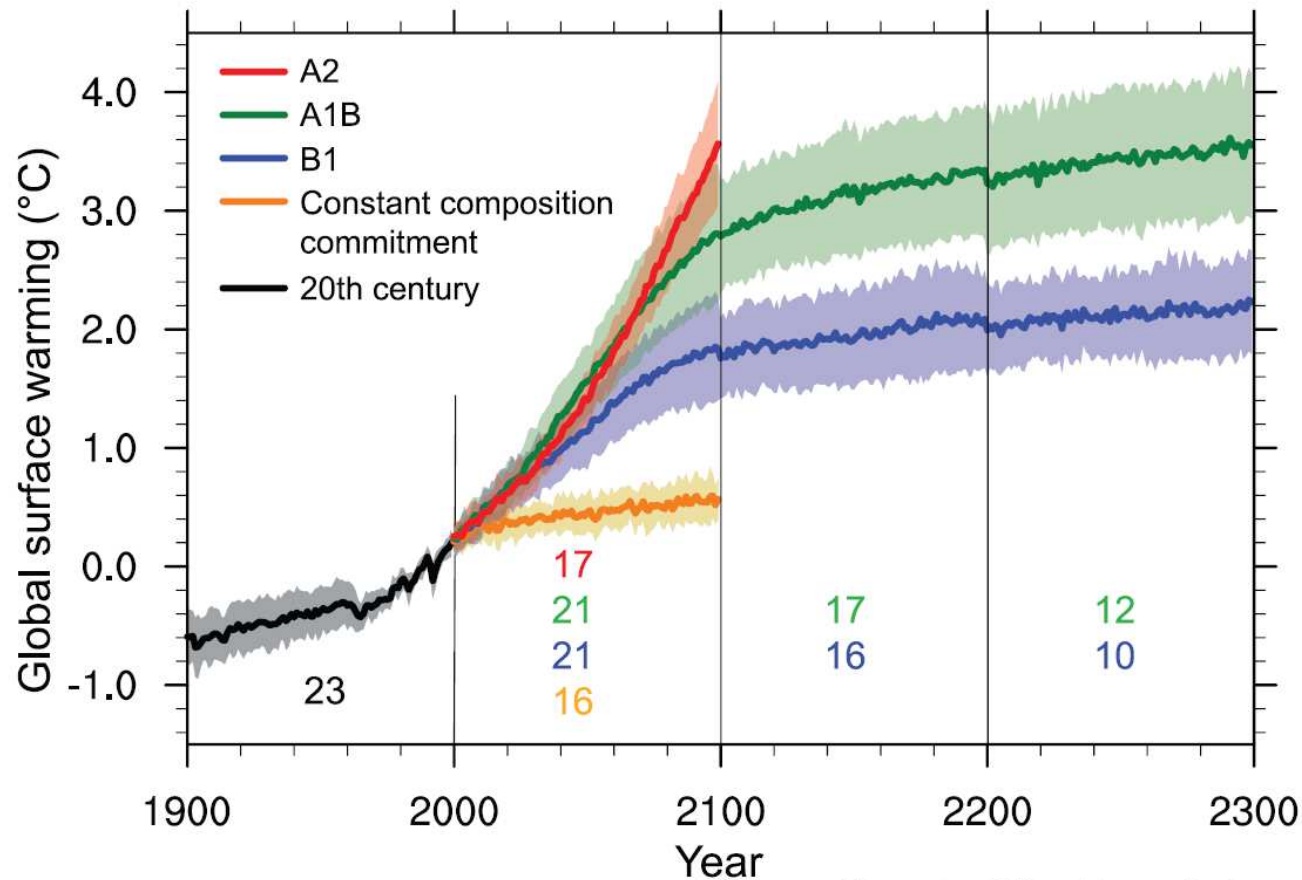




# 排出量を減らせば、大気中濃度は低下する

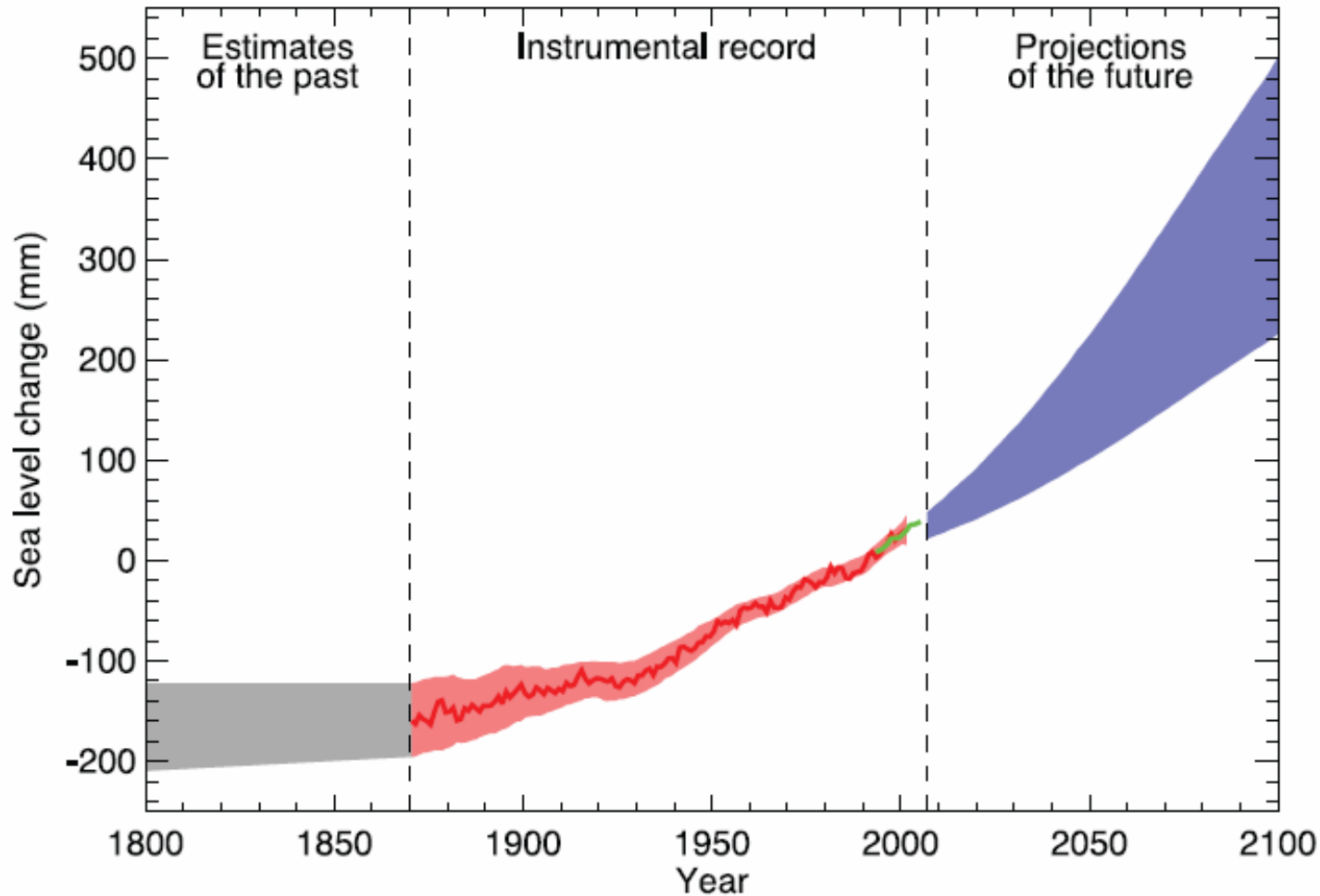
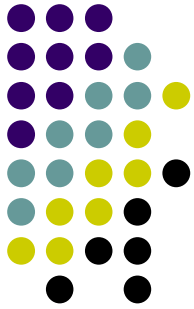


# Temperature rise



**Figure 10.4.** Multi-model means of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th-century simulation. Values beyond 2100 are for the stabilisation scenarios (see Section 10.7). Linear trends from the corresponding control runs have been removed from these time series. Lines show the multi-model means, shading denotes the  $\pm 1$  standard deviation range of individual model annual means. Discontinuities between different periods have no physical meaning and are caused by the fact that the number of models that have run a given scenario is different for each period and scenario, as indicated by the coloured numbers given for each period and scenario at the bottom of the panel. For the same reason, uncertainty across scenarios should not be interpreted from this figure (see Section 10.5.4.6 for uncertainty estimates).

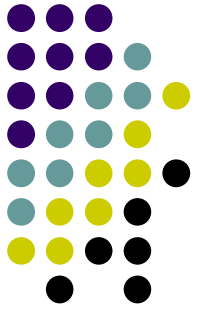
# Sea level rise



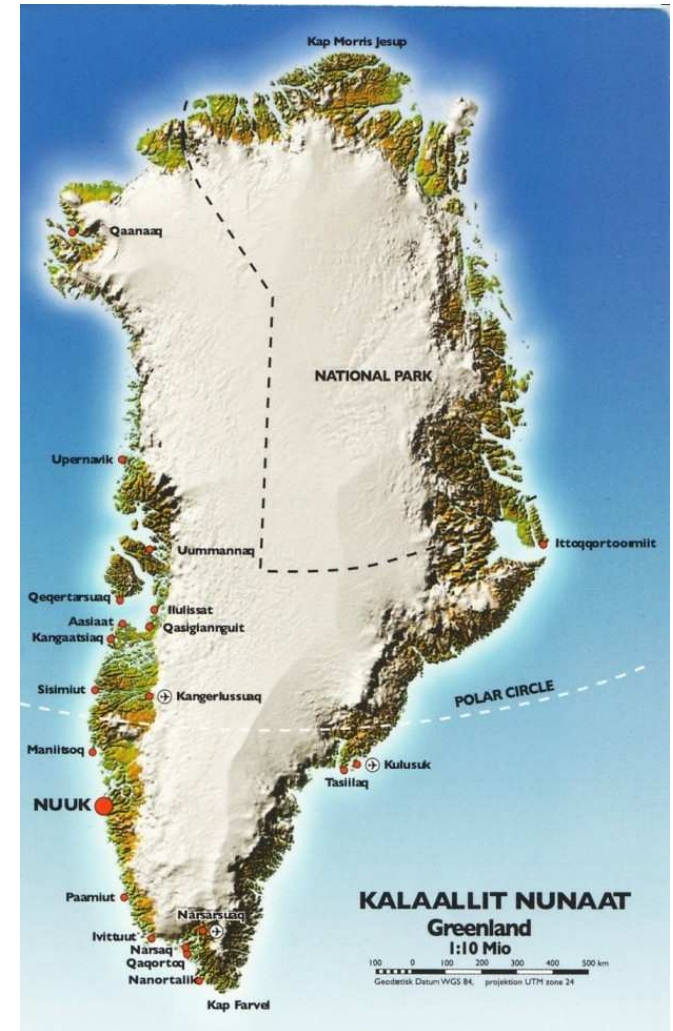
ation from the  
the period before  
y shading shows  
e (Section 6.4.3).  
gauges (Section  
a smooth curve.  
te altimetry. The  
ES A1B scenario  
een calculated

*independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario (see Chapter 10 for a discussion of sea level rise projections for other scenarios considered in this report). Over many centuries or millennia, sea level could rise by several metres (Section 10.7.4).*

# 海面上昇 (2)



- 氷床の融解 (IPCC AR4)
  - グリーンランドの氷床の縮小が続き、2100年以降の海面水位上昇の要因となると予測される。
  - 世界の平均気温が1.9~4.6°C上昇すると、…、表面の質量収支が負に転じると予測される…。
  - 質量収支が数千年間負の値であり続ければ、グリーンランド氷床は完全に消滅し、約7mの海面水位上昇に寄与するだろう。



# Technologies could realize zero-emission world



Technology transfer to Asian countries

**Japan**

Energy saving, high-efficiency

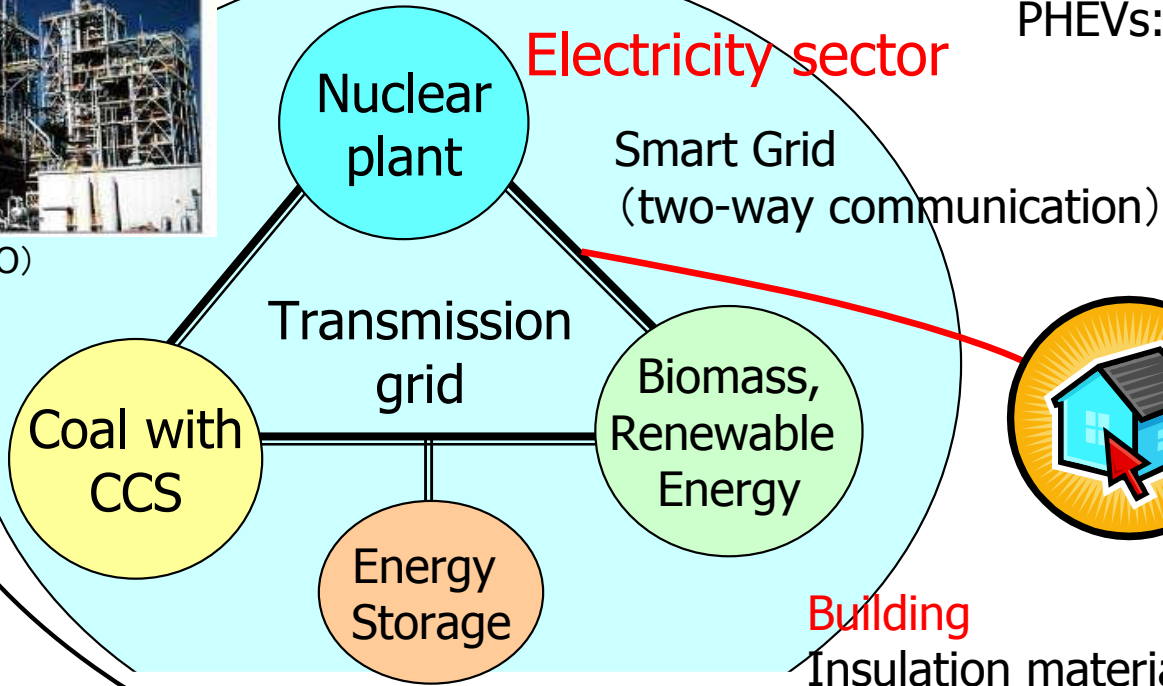
IGCC system

石炭ガス化複合発電パイロットプラント  
(需給共同火力(株)勿来発電所構内)



(Source: TEPCO)

**Electricity sector**



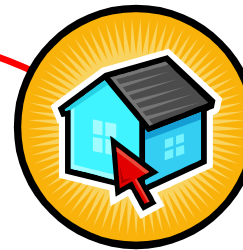
Energy Supply system w/ zero-emission

**Transportation**

PHEVs: Plug-in Hybrid Electric Vehicles



(Source: Toyota)



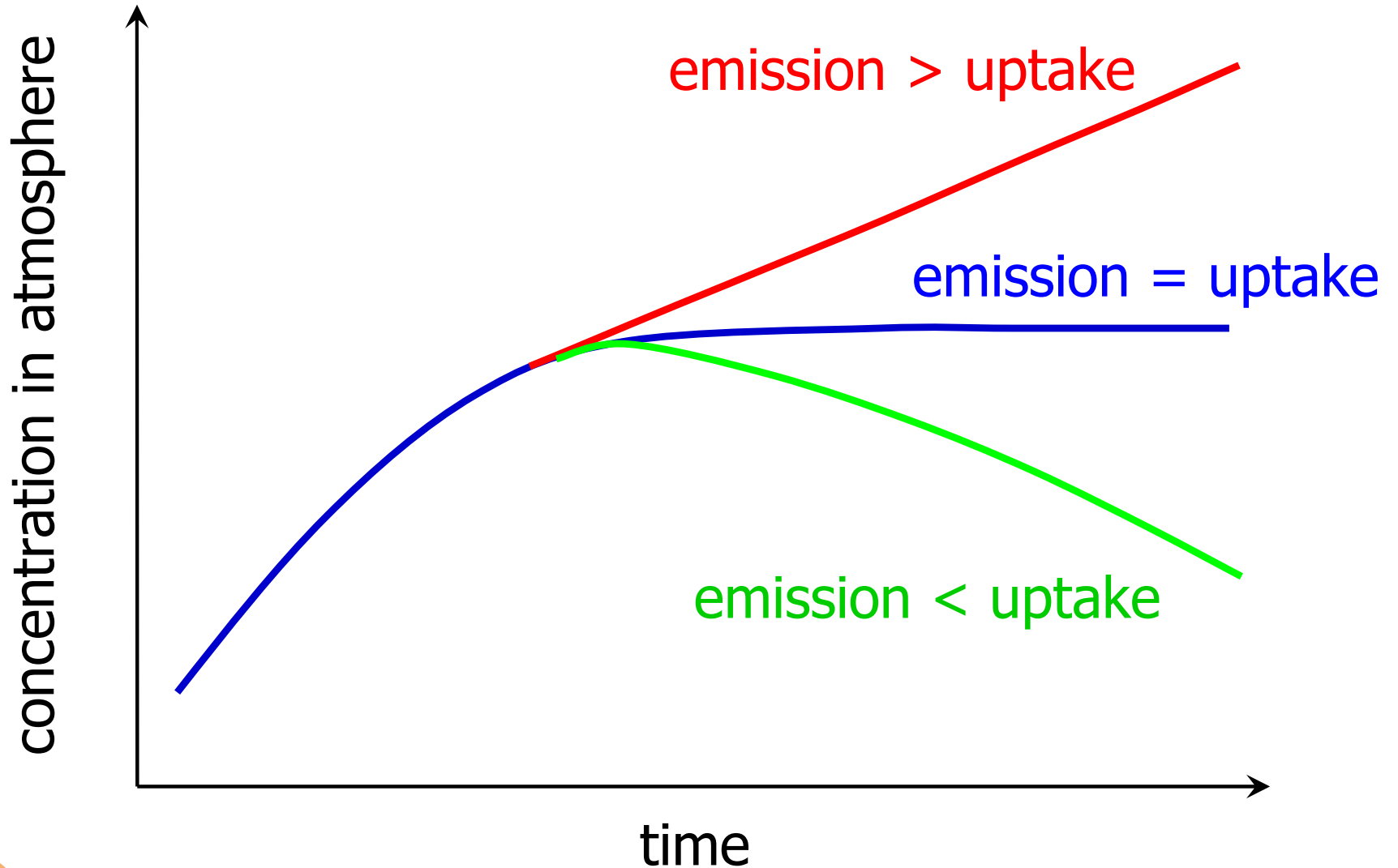
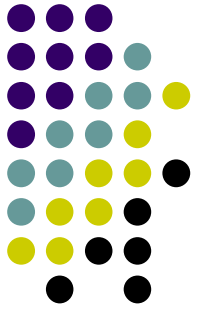
**Home**

- Smart meter
- Heat pump
- IH cooking tool

**Building**

- Insulation materials
- Smart meter
- Cooling system

# CO<sub>2</sub> emission vs. CO<sub>2</sub> uptake





# What is Plug-in Hybrid Electric Vehicle

