District cooling system in APEC

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Outline

- Background
- District cooling data collection efforts
- District cooling study
- Global efforts
- Closing thoughts

Background




Milestone

2016
- 16th APEC Energy Statistics Workshop, issue on the increasing use of district cooling

2018
- EGEDA conducted study on district cooling

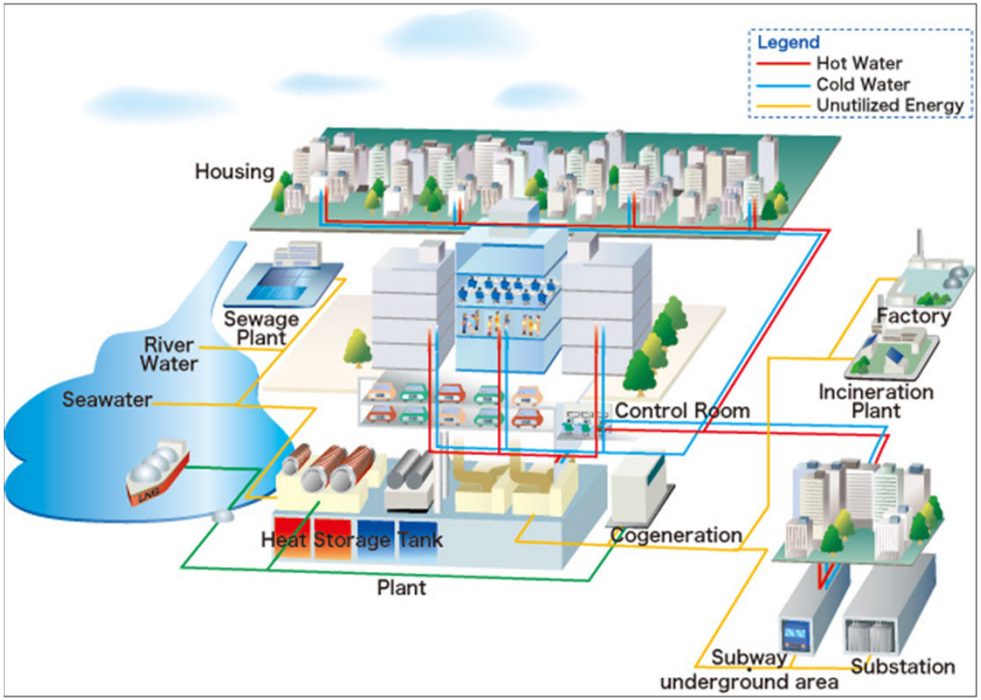
2018
- EGEDA revised annual energy questionnaire (2016 data)

2019 ~
- EGEDA continues its position to consider cooling as an energy product
- Newsletter for UN, presentation at international events

2022
- TT-SIEC was formed by UN Statistical Commission (UNSC) to discuss new energy products and technologies

EGEDA's initial position on cooling

- District cooling and district heating production and delivery of service are similar
  - Energy is also used to generate chilled water and heat production for district heating is considered a transformation process
- Building efficiencies are measured by energy use intensity (EUI) in kWh/m2
  - Excluding chilled water will result in lower (EUI) and understate the actual energy consumption of the building
- There is huge potential for the use of free cooling in the production of chilled water
  - If district cooling is considered an energy product, the use of free cooling can be considered renewable energy (RE) use, increasing the share of RE in the energy mix
  - This would also encourage many economies/countries to use free cooling resulting in a lower carbon energy supply



Source: (JSHBA, n.d.)

District cooling data collection efforts




What data should be collected?

Plant name		
Capacity	**GJ**	
Fuel Inputs	**GJ**	
Coal	GJ	
Natural gas	GJ	
Fuel Oil	GJ	
Diesel	GJ	
Other oil products	GJ	
Biomass	GJ	
Municipal solid waste	GJ	
Electricity	GJ	
Others	GJ	
Chilled water ouput	**GJ**	
Chilled water sales	**GJ**	**0**
Industrial	GJ	0
Iron and steel	GJ	
Chemical (incl. petrochemical)	GJ	
Non-ferrous metals	GJ	
Non-metallic minerals	GJ	
Transport equipments	GJ	
Machinery	GJ	
Mining and quarrying	GJ	
Food, beverages and tobacco	GJ	
Pulp, paper and printing	GJ	
Wood and wood products	GJ	
Construction	GJ	
Textile and leather	GJ	
Not elsewhere specified	GJ	
Commercial/Public service	GJ	
Residential	GJ	

Plant name		
Electricity generation capacity	**MW**	
Chilled water production capacity	**GJ**	
Fuel Inputs	**GJ**	**0**
Coal	GJ	
Natural gas	GJ	
Fuel Oil	GJ	
Diesel	GJ	
Other oil products	GJ	
Biomass	GJ	
Municipal solid waste	GJ	
Waste heat	GJ	
Electricity from the grid	GJ	
Chilled water ouput	**GJ**	
Electricity output	**GJ**	
Electricity used in chillers	GJ	
Other own-use of electricity	GJ	
Electricity sold	GJ	
Chilled water sales	**GJ**	**0**
Industrial	GJ	0
Iron and steel	GJ	
Chemical (incl. petrochemical)	GJ	
Non-ferrous metals	GJ	
Non-metallic minerals	GJ	
Transport equipments	GJ	
Machinery	GJ	
Mining and quarrying	GJ	
Food, beverages and tobacco	GJ	
Pulp, paper and printing	GJ	
Wood and wood products	GJ	
Construction	GJ	
Textile and leather	GJ	
Not elsewhere specified	GJ	
Commercial/Public service	GJ	
Residential	GJ	

- ***We only need the energy inputs, chilled water output and sold.***
- ***In the case of thermal energy storage, energy input and output are both electricity.***

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Questionnaire revision

Table 1c Chilled water production, for 2016 data collection

Chilled water[4] production (Table 1c)

Unit: *select unit*

		Thermal			Hydro	Nuclear	Geo-thermal	Other renewable energy						Others[3]	Total
		Coal	Oil	Gas				Solar	Tide, wave, ocean	Wind	Biomass	Wastes[1]	Biogas[2]		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N
Main Activity Producers															
Gross chilled water production	1	0	0	0		0	0	0			0	0	0	0	0
District cooling plants	2														0
Cooling and power plants	3														0
Own Use by Plant	4	0	0	0		0	0	0			0	0	0	0	0
District cooling plants	5														0
Cooling and power plants	6														0
Net chilled water production	7	0	0	0		0	0	0			0	0	0	0	0
District cooling plants	8	0	0	0		0	0	0			0	0	0	0	0
Cooling and power plants	9	0	0	0		0	0	0			0	0	0	0	0
Autoproducers															
Chilled water sold	16	0	0	0		0	0	0			0	0	0	0	0
District cooling plants	17														0
Cooling and power plants	18														0

Transformation in Coal, Oil, Gas and NRE

APEC-ASEAN joint format for annual energy data
Transformation and energy sector (Table 2)[1]

		Primary fuels				
		Coking coal	Anthracite	Other bituminous coal	Sub-bituminous Coal	Lig
		1000 metric tons	*1000 metric tons*	*1000 metric tons*	*1000 metric tons*	*1000 to*
		A	B	C	D	
TOTAL TRANSFORMATION SECTOR	1	0	0	0	0	
Patent fuel plants	2					
Coke ovens	3					
Gas works plants	4					
Natural gas blending plants[2]	5					
Blast furnaces	6					
BKB/PB plants	7					
Main activity producer	8	0	0	0	0	
Electricity plants	9					
CHP plants	10					
Heat plants	11					
District Cooling Plants	12					
Autoproducers	13	0	0	0	0	
Electricity plants	14					
CHP plants	15					
Heat plants	16					
District Cooling Plants	17					
Petrochemical industry	18					
Petroleum refineries	19					
Gas-to-liquid plants	20					
Liquefaction plants (coal to oil)	21					
TOTAL ENERGY SECTOR	22	0	0	0	0	
Coal mines	23					
Oil and gas extraction	24					
Patent fuel plants	25					
Coke ovens	26					
Gas works plants	27					
Natural gas blending plants	28					
Blast furnaces	29					
BKB/PB plants	30					
Petroleum refineries	31					
Electricity, CHP and heat plants	32					

For Autoprodcers, only fuel used for heat/chilled water sold to be reported

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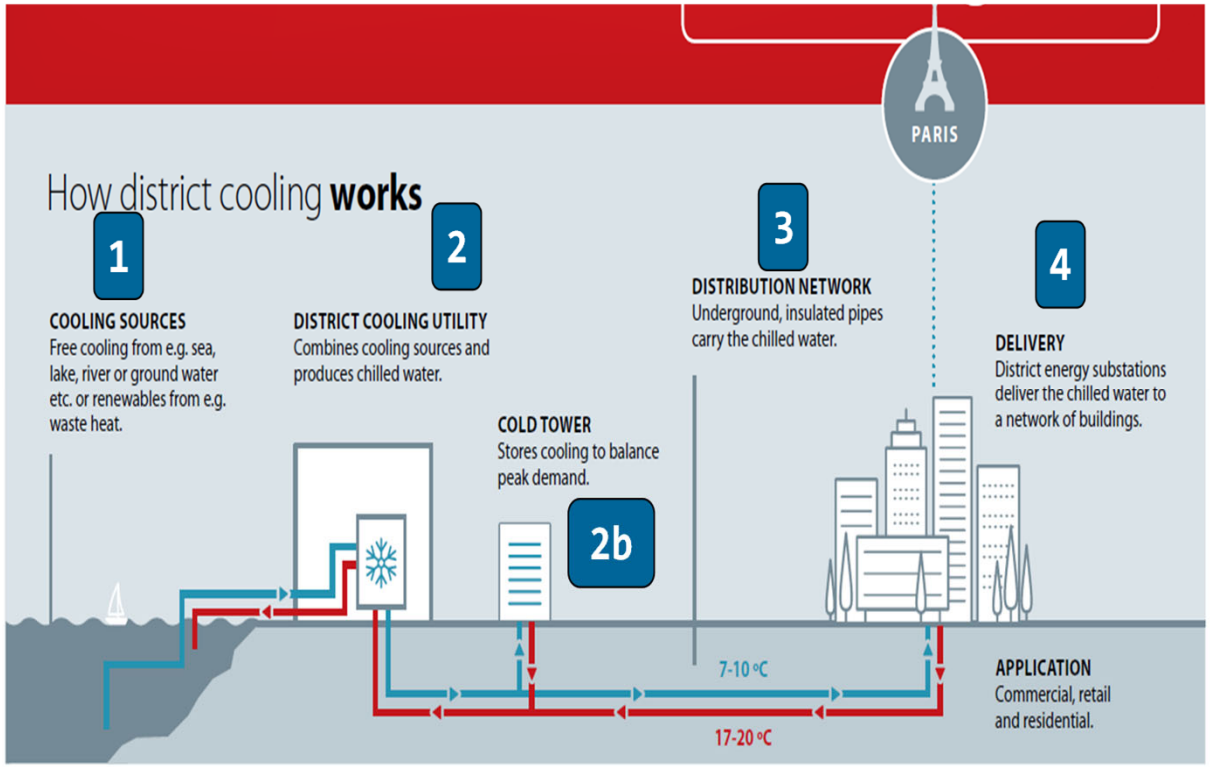
District cooling study

Initial findings

Economy	With DCS	Info Available	DC data available	1st DCS	Cooling capacity (estimate)		Floor area (estimate)	Installa -tions	Regulated
	Yes/No	Yes/No	Yes/No	Year	RT	MWth	million m²	Number	Yes/No
Australia				2010	17 600	62	0 25+	4+	
Brunei Darussalam									
Canada				1924	325 291	1 144	22 5	39	
Chile									
China				2001	588 586	2 070	21 7	10	
Hong Kong, China				2013	80 754	284	1 7	10	
Indonesia									
Japan				1972	1 126 007	3 960	49 5	81	
Korea				2005	55 163	194	181 9	121	
Malaysia				1998	190 000	668	10 0	11	
Mexico									
New Zealand				2012					
PNG									
Peru									
Philippines				2010	70 775	249	0 53+	11	
Russia									
Singapore				2006	90 000	317	1 4	3	
Chinese Taipei									
Thailand				2006	82 000	288	4 4	6	
United States				1962	4 404 776	15 491	183 8	416	
Viet Nam									

Sources : AUS: (JCU, 2012)

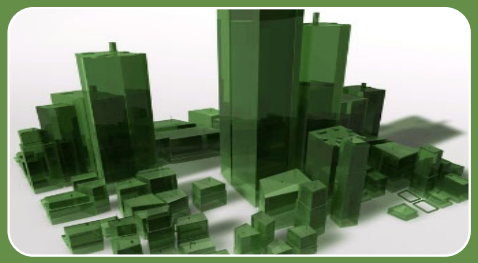
How district cooling works?



Sources: Euroheat&Power, Cool Alliance (Logstor and Danfoss), Climespace

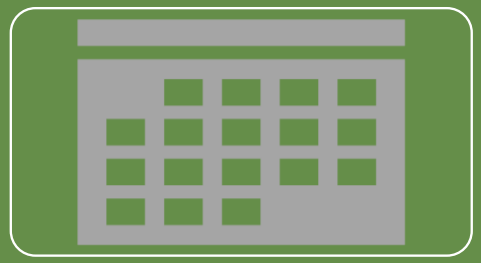
1. Fuels are burned to generate cooling;
2. Chilled water is generated at the district cooling plant;
2b. Chilled water is stored;
3. Chilled water is distributed through underground pipes
4. Cool water is delivered to customers

Four generations of district cooling



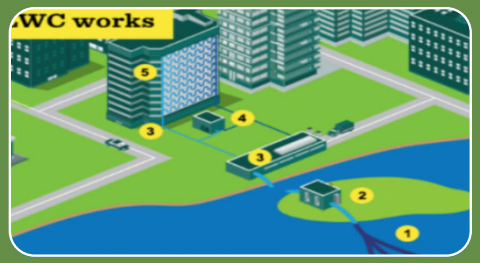
1st generation
Interconnecting buildings with a network saving capacity

- not only possible to measure the actual consumption of the whole building hour by hour, but also to measure the total consumption to the network



2nd generation
Chilled water storage facility/ Thermal energy storage system

- Stores the partial capacity of the building cooling load during off peak hours (night-time) and discharging it on peak hours (day-time); optimizing the operation of the network



3rd generation
More efficient cooling/deep lake water cooling

- Integration of DC network (ground source cooling, or could also be other sources, e.g. fluctuating sources) and chilled water tank

4th generation
Combined heating and cooling

- Heat pump-based systems, cooling is a waste product, and it is obvious to co-ordinate the location of the heat pumps with the cooling potential and gain income from sale of cooling capacity and cooling energy

- Energy inputs are either gas or electricity

Case economy - Malaysia

CASE ECONOMY● MALAYSIA

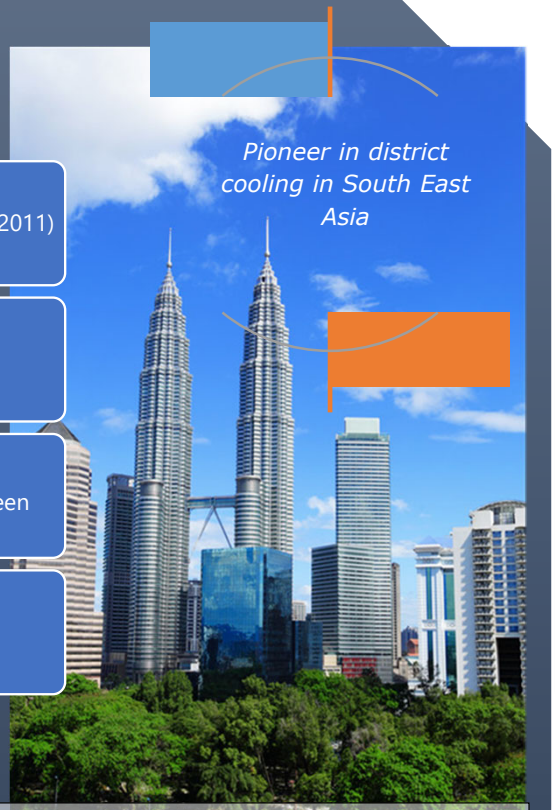
OVERVIEW

Macro-indictors (2017)
GDP • 848.29 billion USD PPP (constant 2011)
Population • 31.11 million

Energy (2017)
TPES • 94 Mtoe (Gas • 44%)
TFC • 60 Mtoe (Transport • 36%)

Climate
average daily temperature varying between 21°C to 32°C

District Cooling Systems
Year started • 1998
Cooling capacity • 190 000 RT



BRIEF HISTORY

There was no definite date when district cooling system has started in Malaysia. In the presentation by Gas District Cooling (GDC) Putrajaya Sdn Bhd during the site visit, the first district cooling commissioned was in 1998 at Presint1, Putrajaya. The cooling plant has 6.5 MW electricity output and 32 000 refrigeration tonnes (RT)[9] chilled water output; (energy) sources included methane gas, electricity and chilled water.

Month	Energy Input (KWh)		Total Energy Input (KWh)	Energy Output (KWhTR)	Plant Efficiency (%)
	Gas	Electricity			
Apr-16	46,008,805	2,943,298	48,952,103	32,766,817	67%
May-16	47,757,092	3,127,076	50,884,168	31,717,484	62%
Jun-16	39,363,605	2,885,152	42,248,757	29,185,187	69%
Jul-16	44,988,434	2,385,820	47,374,254	27,606,714	58%
Aug-16	46,881,086	2,766,994	49,648,080	30,518,873	61%
Sep-16	42,124,617	3,655,244	45,779,861	29,058,274	63%

Energy input ● Gas and electricity
Output ● chilled water

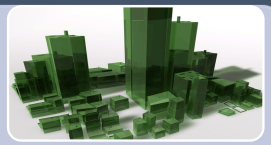
Types ● 1st generation and 2nd generation

Case economy - Japan

CASE ECONOMY ● JAPAN

Photos: *Tokyo business district (top left); meeting with experts from Japan Heat Supply Business Association (bottom left) and Shinjuku district heating and cooling system of Tokyo the largest system in Japan (right).*

OVERVIEW



Macro-indicators (2017)

GDP • USD 4 932.5 billion (PPP constant 2011)

Population • 126.9 million

Energy (2017)

TPES • 432 Mtoe

(Oil • 41%)

TFC • 293 Mtoe (Industry • 30%)

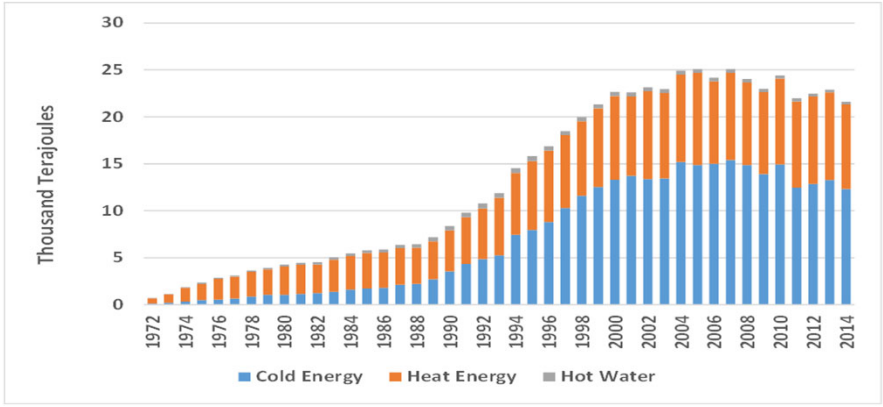
Climate

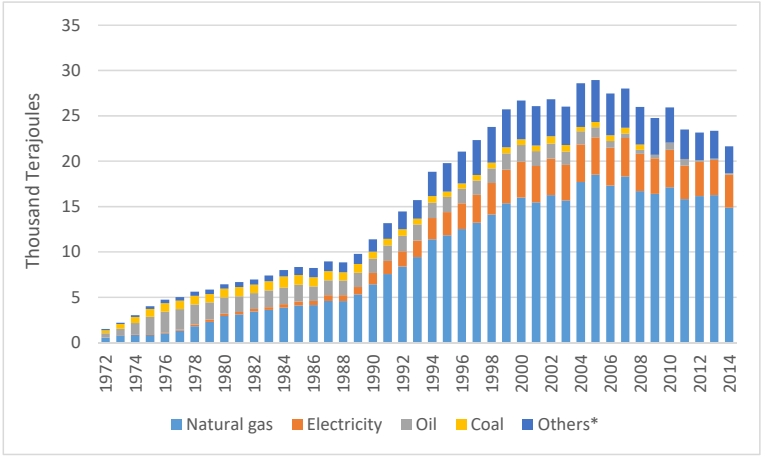
- four distinct seasons but the overall climate is temperate;
- Warmer temperature can be experienced in Tokyo with an average temperature of 6°C (42°F) in January, average for August 27°C (81°F), and the annual average 16°C (61 °F)

District cooling system

- District heating and cooling (DHC) is the third largest energy utility, following the electric and gas companies

The district heating and cooling system in Japan was first introduced in 1970 at the site of Osaka EXPO. Data on district cooling is compiled by the Japan Heat Supply Business Association (JHSBA).





Global efforts




Background

- The United Nations Statistical Commission (UNSC), at its 53rd session, "requested the Committee of Experts on International Statistical Classifications to revise the Standard International Energy Product Classification (SIEC) to improve harmonization between SIEC and CPC.
- In July 2022 the task team on the Standard International Energy Products Classification SIEC (TT-SIEC) was established.
- TT-SIEC is mandated by the UNSC to submit the revised classification to the UNSC at its 55th session in 2025 through the UN Committee of Experts on International Statistical Classifications.
- Members were from various national statistics offices (Australia, Austria, Canada, El Salvador, Ghana, Vienna, Malaysia, Denmark, Kenya, New Zealand, Netherlands, Kazakhstan, etc), international agencies, IEA, APERC (APEC), EUROSTAT, IRENA, IAEA, FAO, UNSD.
- Monthly meetings since March 2023.
- More than 20 issues to consider including hydrogen/ammonia (issue #4), oil shale and oil sands (issue #7) and cooling (issue #10).

Cooling as statistics

Same principle that was established in heat

- Methodology for main activity producers vs. autoproducers; i.e. cover only cold sold and represent coldness self-consumed as consumption of energy from which it was produced.
- Cover only active systems for cooling, including district heating/cooling systems, regardless of whether the energy source is “free energy”
- Only stationary cooling and heating systems shall be counted (mobile machinery and vehicles, e.g. trains, planes, are excluded.)
- Only heat and cold actually used should be reported

Exclusions

- Cooling for mobile machinery and vehicles, e.g. trains, planes, are excluded.
- End-use systems are excluded such as refrigeration, freezing
- Temperature changes of residual heat and cold are excluded from reporting heat and cold.

Sample energy balance table

	Natural gas	Seabed water	Electricity	Heat	Cold
Primary production	50 000	161	×	×	×
Imports	0	×	100	0	0
Exports	14 368	×	342	0	0
Stock changes	0	×	×	×	×
Total energy supply	35 632	161	-242	0	0
Transformation input	24 021	151	66	0	0
Electricity only	20 420	×	0	0	0
CHP	1 100	0	0	0	0
CCP	247	0	33	0	0
CCHP (trigeneration)	2 032	0	33	0	0
Heat only	222	×	0	0	0
Cold only	0	151	0	0	0
Transformation output	×	×	9 868	1 198	199
Electricity only	×	×	8 168	×	×
CHP	×	×	500	500	×
CCP	×	×	200	×	24
CCHP (trigeneration)	×	×	1 000	500	24
Heat only	×	×	×	198	×
Cold only	×	×	×	×	151
Energy sector	500	0	95	17	0
Transmission and distribution losses	111	×	465	159	19
Final energy consumption	11 000	10	9 000	1 022	180
Industry	5 000	10	4 000	500	123
Households	6 000	0	5 000	522	57

Source :EUROSTAT report to TT-SIEC

Closing thoughts




Closing thoughts: better data = better analysis

- Cooling system is equally important as district heating aspects of the energy systems.
- Treating cooling the same way as heating in energy statistics would provide better information for analysis of the potential for energy efficiency improvement, increasing renewable energy share and expanding district cooling supply.
- Needs to understand the system well to separate exclusions.
- Device ways to collect data, need to collaborate with district cooling producers (mostly private). Make use of any “law” or “regulatory body” .

Asia-Pacific Economic Cooperation

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Thank you for your kind attention.

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