

4TH - 5TH OCTOBER 2023

Accelerating PV Adoption in Singapore: The Potential of Advanced Energy Communities

Authors: Kang Jidong, Martín Mosteiro-Romero,

Yuming Fu,

Christoph Waibel

Institutes:(FCL) FUTURE (FRS) FUTURE CITIES RESILIENT LABORATORY SYSTEMS GLOBAL





Definition

PV adoption rate =

(Self-sufficiency rate)

Research questions

- 1. How much efficiency gain can be created by AEC?
- 2. What are the sources of efficiency gain of AEC?
- 3. Efficiency gain \rightarrow PV adoption?

Contribution

- A coherent optimization framework to study the interface between user demand and supply technologies.
- Evaluate the various technology components and business model.
- Apply to various building architypes in Singapore.

Methods



Fig. 3 Methodological framework for data simulation and optimization

9 building architypes Industrial_Woodlands (19 buildings) HDB_Punggol Condo_Punggol (23 buildings) (17 buildings) Landed_Punggol (23 buildings) HDB_SengKang (21 buildings) University_NUS (21 buildings) Industrial_Changi (19 buildings) Commercial_CBD Shopping_Suntec (23 buildings) (21 buildings)

Results (Electricity tariff = 20 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (Ce	ents/kWh)	Total		Increment	tal reduction	in LCOE		Sell ba grid (I	ack to ⁄IWh)	Self-suf (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	20	19.1	4.3%	0.0%	0.0%	0.3%	0.0%	4.0%	0.03	0	6.3%	7.4%	
Condo (Punggol)	0.92	16.4	15	8.7%	1.3%	0.0%	1.4%	1.3%	4.7%	0.27	0.09	36.4%	41.4%	
HDB (Punggol)	1.06	16.9	15.5	8.2%	0.9%	0.0%	1.5%	0.8%	5.0%	0.12	0.04	36.6%	42.7%	
HDB (Sengkang)	1.21	15.7	14.1	10.3%	2.2%	0.0%	1.2%	2.4%	4.5%	1.79	1.21	44.9%	48.9%	
Industrial (Changi)	0.3	17.6	16.5	6.5%	0.0%	0.0%	1.7%	0.0%	4.8%	0	0	24.6%	28.7%	
Industrial (Woodlands)	0.19	18.8	17.7	5.5%	0.0%	0.0%	1.0%	0.0%	4.5%	0	0	15.5%	18.1%	
Shopping (Suntec)	0.12	19.7	18.6	5.7%	0.0%	0.0%	0.4%	0.0%	5.2%	0.01	0	8.9%	10.4%	
University (NUS)	0.21	19.8	19.3	2.5%	0.0%	0.0%	0.3%	0.0%	2.3%	0	0	9.8%	11.1%	
Landed (Punggol)	3.74	11.1	9.5	14.5%	0.0%	0.0%	3.4%	6.1%	5.0%	0.89	0.99	196.1%	226.7%	
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Results (Electricity tariff = 20 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (Ce	ents/kWh)	Total		Increment	al reduction	in LCOE		Sell ba grid (I	ack to ⁄IWh)	Self-suf (PV ad	ficiency option)	Dynamic
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	Solar density (kWp/kWh) 0.13 0.92 1.06 1.21 0.3 0.19 0.12 0.21 3.74	Solar density (kWp/kWh) LCOE (C Solar lease 0.13 Solar lease 0.13 20 0.92 16.4 1.06 16.9 1.21 15.7 0.3 17.6 0.19 18.8 0.12 19.7 0.21 19.8 3.74 11.1	LCOE (Cents/kWh)Solar density (kWp/kWh)LCOE (Cents/kWh) 0.13 Solar leaseAEC 0.13 2019.1 0.92 16.415 1.06 16.915.5 1.21 15.714.1 0.3 17.616.5 0.19 18.817.7 0.12 19.718.6 0.21 19.819.3 3.74 11.19.5Table 1	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Solar lease AEC Total drop in LCOE 0.13 20 19.1 4.3% 0.92 16.4 15 8.7% 1.06 16.9 15.5 8.2% 1.21 15.7 14.1 10.3% 0.3 17.6 16.5 6.5% 0.19 18.8 17.7 5.5% 0.21 19.7 18.6 5.7% 0.21 19.8 19.3 2.5% 3.74 11.1 9.5 14.5%	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Total drop in LCOE Load pooling 0.13 20 19.1 4.3% 0.0% 0.92 16.4 15 8.7% 1.3% 1.06 16.9 15.5 8.2% 0.9% 1.21 15.7 14.1 10.3% 2.2% 0.3 17.6 16.5 6.5% 0.0% 0.19 18.8 17.7 5.5% 0.0% 0.12 19.7 18.6 5.7% 0.0% 0.21 19.8 19.3 2.5% 0.0% 3.74 11.1 9.5 14.5% 0.0%	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Total drop in LCOE Increment 0.13 Solar lease AEC Load pooling Storage battery 0.13 20 19.1 4.3% 0.0% 0.0% 0.92 16.4 15 8.7% 1.3% 0.0% 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.21 15.7 14.1 10.3% 2.2% 0.0% 0.19 18.8 17.7 5.5% 0.0% 0.0% 0.12 19.7 18.6 5.7% 0.0% 0.0% 0.21 19.8 19.3 2.5% 0.0% 0.0% 3.74 11.1 9.5 14.5% 0.0% 0.0%	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Incremental reduction 0.13 20 19.1 4.3% 0.0% 0.0% 0.3% 0.92 16.4 15 8.7% 1.3% 0.0% 1.4% 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.2% 0.13 17.6 16.5 6.5% 0.0% 0.0% 1.2% 0.92 16.4 15 8.7% 1.3% 0.0% 1.4% 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.2% 0.3 17.6 16.5 6.5% 0.0% 0.0% 1.7% 0.19 18.8 17.7 5.5% 0.0% 0.0% 0.4% 0.21 19.7 18.6 5.7% 0.0% 0.0% 0.3% 3.74 11.1 9.5 14.5% 0.0% 0.0% 3.4%	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Incremental reduction in LCOE 0.13 Solar lease AEC Load pooling Storage battery Space Utilization Demand Flexibility 0.13 20 19.1 4.3% 0.0% 0.0% 0.3% 0.0% 0.92 16.4 15 8.7% 1.3% 0.0% 1.4% 1.3% 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.2% 2.4% 0.3 17.6 16.5 6.5% 0.0% 0.0% 1.2% 2.4% 0.19 18.8 17.7 5.5% 0.0% 0.0% 1.0% 0.0% 0.12 19.7 18.6 5.7% 0.0% 0.0% 0.4% 0.0% 0.21 19.8 19.3 2.5% 0.0% 0.0% 3.4% 6.1% 0.21 19.8 19.3 14.5% 0.0% 0.0% 3.4% 6.1%	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Solar density (KWp/kWh) LCOE (Cents/kWh) Total lease Incremental reduction in LCOE Sell br grid (f 0.13 Solar lease AEC Total LCOE Load boding Storage battery Space Utilization Demand Pexibility System Solar lease Solar lease 0.13 20 19.1 4.3% 0.0% 0.0% 0.3% 0.0% 4.0% 0.03 0.92 16.4 15 8.7% 1.3% 0.0% 1.4% 1.3% 4.7% 0.27 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.5% 0.8% 5.0% 0.12 1.21 15.7 14.1 10.3% 2.2% 0.0% 1.2% 2.4% 4.5% 1.79 0.3 17.6 16.5 6.5% 0.0% 0.0% 1.0% 0.0% 4.8% 0 0.12 19.7 18.8 17.7 5.5% 0.0% 0.0% 0.4% 0.0% 5.2% 0.01 0.21 19.8 19.3	Solar density (kWp/kWh) LCOE (Cents/kWh) Total drop in LCOE Incremental reduction in LCOE Sell back to grid (MWh) 0.13 Solar lease AEC Total drop in LCOE Storage battery Space Utilization Demand Flexibility System Coupling Solar lease AEC 0.13 20 19.1 4.3% 0.0% 0.0% 0.3% 0.0% 4.0% 0.03 0 0.92 16.4 15 8.7% 1.3% 0.0% 1.4% 1.3% 4.7% 0.27 0.09 1.06 16.9 15.5 8.2% 0.9% 0.0% 1.5% 0.8% 5.0% 0.12 0.04 1.21 15.7 14.1 10.3% 2.2% 0.0% 1.2% 2.4% 4.5% 1.79 1.21 0.3 17.6 16.5 6.5% 0.0% 0.0% 1.0% 0.0% 4.8% 0 0 0.12 19.7 18.6 5.7% 0.0% 0.0% 0.3% 0.0% 2.3% 0	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$

Results (Electricity tariff = 20 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Increment	al reduction	in LCOE		Sell ba grid (N	ack to ⁄IWh)	Self-suf (PV ad	ficiency option)	Dynamic
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Commercial (CBD)	0.13	20	19.1	4.3%	0.0%	0.0%	0.3%	0.0%	4.0%	0.03	0	6.3%	7.4%	
Condo (Punggol)	0.92	16.4	15	8.7%	1.3%	0.0%	1.4%	1.3%	4.7%	0.27	0.09	36.4%	41.4%	
HDB (Punggol)	1.06	16.9	15.5	8.2%	0.9%	0.0%	1.5%	0.8%	5.0%	0.12	0.04	36.6%	42.7%	
HDB (Sengkang)	1.21	15.7	14.1	10.3%	2.2%	0.0%	1.2%	2.4%	4.5%	1.79	1.21	44.9%	48.9%	
Industrial (Changi)	0.3	17.6	16.5	6.5%	0.0%	0.0%	1.7%	0.0%	4.8%	0	0	24.6%	28.7%	
Industrial (Woodlands)	0.19	18.8	17.7	5.5%	0.0%	0.0%	1.0%	0.0%	4.5%	0	0	15.5%	18.1%	
Shopping (Suntec)	0.12	19.7	18.6	5.7%	0.0%	0.0%	0.4%	0.0%	5.2%	0.01	0	8.9%	10.4%	
University (NUS)	0.21	19.8	19.3	2.5%	0.0%	0.0%	0.3%	0.0%	2.3%	0	0	9.8%	11.1%	
Landed (Punggol)	3.74	11.1	9.5	14.5%	0.0%	0.0%	3.4%	6.1%	5.0%	0.89	0.99	100.1%	220.7%	

Table 1. Potential and drivers of AEC for efficiency gain and PV adoption

Results (Electricity tariff = 20 cents/kWh, feed-in tariff = 16 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Incremen	tal reduction	in LCOE		Sell ba grid (I	ack to MWh)	Self-suf (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	20	19.1	4.3%	0.0%	0.0%	0.3%	0.0%	4.0%	0.03	0	6.3%	7.4%	
Condo (Punggol)	0.92	16.2	14.9	8.1%	0.4%	0.0%	2.0%	0.8%	4.9%	1.05	0.93	45.1%	52.2%	
HDB (Punggol)	1.06	16.8	15.5	7.7%	0.3%	0.0%	1.6%	0.6%	5.1%	0.54	0.15	40.7%	44.4%	
HDB (Sengkang)	1.21	15	13.5	9.6%	0.5%	0.0%	2.8%	1.0%	5.4%	3.35	2.82	54.5%	60.2%	
Industrial (Changi)	0.3	17.6	16.5	6.5%	0.0%	0.0%	1.7%	0.0%	4.8%	0	0	24.6%	28.7%	
Industrial (Woodlands)	0.19	18.8	17.7	5.5%	0.0%	0.0%	1.0%	0.0%	4.5%	0	0	15.5%	18.1%	
Shopping (Suntec)	0.12	19.7	18.6	5.7%	0.0%	0.0%	0.4%	0.0%	5.2%	0.04	0	8.9%	10.4%	<u> </u>
University (NUS)	0.21	19.8	19.3	2.5%	0.0%	0.0%	0.3%	0.0%	2.3%	0	0	9.8%	11.1%	
Landed (Punggol)	3.64	0	0 Table 1	0.0%	0.0%		0.0%	0.0%	0.0%	0.9	0.96	198.1%	217.4%	

Results (Electricity tariff = 20 cents/kWh, feed-in tariff = 16 cents/kWh)

Building	Solar	LCOE (Ce	ents/kWh)	Total		Increment	al reduction	in LCOE		Sell ba grid (I	ack to //Wh)	Self-suf (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
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Condo (Punggol)	0.92	16.2	14.9	8.1%	0.4%	0.0%	2.0%	0.8%	4.9%	1.05	0.93	45.1%	52.2%	
HDB (Punggol)	1.06	16.8	15.5	7.7%	0.3%	0.0%	1.6%	0.6%	5.1%	0.54	0.15	40.7%	44.4%	
HDB (Sengkang)	1.21	15	13.5	9.6%	0.5%	0.0%	2.8%	1.0%	5.4%	3.35	2.82	54.5%	60.2%	
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Industrial (Woodlands)	0.19	18.8	17.7	5.5%	0.0%	0.0%	1.0%	0.0%	4.5%	0	0	15.5%	18.1%	
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Results (Electricity tariff = 40 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (Co	ents/kWh)	Total		Incremen	tal reduction	in LCOE		Sell ba grid (I	ack to MWh)	Self-suf (PV ad	ficiency option)	Dynamic	
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price	_
Commercial (CBD)	0.13	38.3	36.2	5.5%	0.0%	0.0%	0.6%	0.0%	4.9%	0.03	0	9.4%	10.9%		_
Condo (Punggol)	0.92	29	24.9	14.0%	1.1%	2.8%	1.7%	3.4%	5.1%	0.85	0	45.4%	58.9%		_
HDB (Punggol)	1.06	29.1	25.4	12.8%	0.5%	2.3%	1.4%	3.3%	5.2%	0.76	0	44.3%	61.9%		_
HDB (Sengkang)	1.21	27.8	23	17.4%	1.8%	4.5%	2.1%	3.6%	5.4%	2.93	0	53.7%	76.2%		_
Industrial (Changi)	0.3	32.6	29.8	8.6%	0.0%	0.0%	2.5%	0.0%	6.1%	0	0	25.3%	29.6%	[
Industrial (Woodlands)	0.19	35.6	33.1	7.1%	0.0%	0.0%	1.4%	0.0%	5.6%	0	0	16.1%	18.9%	[
Shopping (Suntec)	0.12	37.8	35.3	6.7%	0.0%	0.0%	0.7%	0.0%	6.0%	0.03	0	9.8%	11.5%	[
University (NUS)	0.21	37.2	35.9	3.6%	0.0%	0.0%	0.8%	0.0%	2.7%	0.02	0	15.8%	17.9%		_
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HDB (Punggol)	1.06	29.1	25.4	12.8%	0.5%	2.3%	1.4%	3.3%	5.2%	0.76	0	44.3%	61.9%	
HDB (Sengkang)	1.21	27.8	23	17.4%	1.8%	4.5%	2.1%	3.6%	5.4%	2.93	0	53.7%	76.2%	
Industrial (Changi)	0.3	32.6	29.8	8.6%	0.0%	0.0%	2.5%	0.0%	6.1%	0	0	25.3%	29.6%	
Industrial (Woodlands)	0.19	35.6	33.1	7.1%	0.0%	0.0%	1.4%	0.0%	5.6%	0	0	16.1%	18.9%	[
Shopping (Suntec)	0.12	37.8	35.3	6.7%	0.0%	0.0%	0.7%	0.0%	6.0%	0.03	0	9.8%	11.5%	[
University (NUS)	0.21	37.2	35.9	3.6%	0.0%	0.0%	0.8%	0.0%	2.7%	0.02	0	15.8%	17.9%	
Landed (Punggol)	3.74	21.2	13.6	35.5% Potoptic	0.0%	23.7%	2.0%	5.9%	3.9%	0.89	0.71	196.1%	222.0%	

Results (Electricity tariff = 40 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Incremen	tal reduction	in LCOE		Sell b grid (l	ack to MWh)	Self-sul (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	38.3	36.2	5.5%	0.0%	0.0%	0.6%	0.0%	4.9%	0.03	0	9.4%	10.9%	
Condo (Punggol)	0.92	29	24.9	14.0%	1.1%	2.8%	1.7%	3.4%	5.1%	0.85	0	45.4%	58.9%	
HDB (Punggol)	1.06	29.1	25.4	12.8%	0.5%	2.3%	1.4%	3.3%	5.2%	0.76	0	44.3%	61.9%	
HDB (Sengkang)	1.21	27.8	23	17.4%	1.8%	4.5%	2.1%	3.6%	5.4%	2.93	0	53.7%	76.2%	
Industrial (Changi)	0.3	32.6	29.8	8.6%	0.0%	0.0%	2.5%	0.0%	6.1%	0	0	25.3%	29.6%	
Industrial (Woodlands)	0.19	35.6	33.1	7.1%	0.0%	0.0%	1.4%	0.0%	5.6%	0	0	16.1%	18.9%	[
Shopping (Suntec)	0.12	37.8	35.3	6.7%	0.0%	0.0%	0.7%	0.0%	6.0%	0.03	0	9.8%	11.5%	[
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Landed (Punggol)	3.74	21.2	13.6	35.5%	0.0%	23.7%	2.0%	5.9%	3.9%	0.89	0.71	196.1%	222.0%	

Results (Electricity tariff = 40 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Incremen	tal reduction	in LCOE		Sell ba grid (N	ack to ⁄IWh)	Self-suf (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	38.3	36.2	5.5%	0.0%	0.0%	0.6%	0.0%	4.9%	0.03	0	9.4%	10.9%	
Condo (Punggol)	0.92	29	24.9	14.0%	1.1%	2.8%	1.7%	3.4%	5.1%	0.85	0	45.4%	58.9%	
HDB (Punggol)	1.06	29.1	25.4	12.8%	0.5%	2.3%	1.4%	3.3%	5.2%	0.76	0	44.3%	61.9%	
HDB (Sengkang)	1.21	27.8	23	17.4%	1.8%	4.5%	2.1%	3.6%	5.4%	2.93	0	53.7%	76.2%	
Industrial (Changi)	0.3	32.6	29.8	8.6%	0.0%	0.0%	2.5%	0.0%	6.1%	0	0	25.3%	29.6%	
Industrial (Woodlands)	0.19	35.6	33.1	7.1%	0.0%	0.0%	1.4%	0.0%	5.6%	0	0	16.1%	18.9%	<u> </u>
Shopping (Suntec)	0.12	37.8	35.3	6.7%	0.0%	0.0%	0.7%	0.0%	6.0%	0.03	0	9.8%	11.5%	
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Landed (Punggol)	3.74	21.2	13.6	35.5%	0.0%	23.7%	2.0%	5.9%	3.9%	0.89	0.71	100.1%	222.0%	

Table 1. Potential and drivers of AEC for efficiency gain and PV adoption

Results (Electricity tariff = 60 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Increment	tal reduction	in LCOE		Sell ba grid (I	ack to MWh)	Self-suf (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	56.4	53	6.1%	0.1%	0.0%	0.8%	0.0%	5.2%	0.04	0	10.2%	11.9%	
Condo (Punggol)	0.92	40.8	29.2	28.4%	0.9%	14.7%	4.0%	2.9%	5.9%	1.67	0	53.6%	84.7%	
HDB (Punggol)	1.06	40.7	28.4	30.2%	0.7%	16.4%	3.8%	3.3%	6.0%	1.76	0	51.8%	96.3%	
HDB (Sengkang)	1.21	39.4	24.2	38.5%	1.3%	23.6%	4.7%	3.5%	5.5%	3.93	0	59.5%	100.0%	
Industrial (Changi)	0.3	47.5	43.1	9.4%	0.0%	0.0%	2.8%	0.0%	6.7%	0	0	25.4%	29.6%	
Industrial (Woodlands)	0.19	52.4	48.3	7.7%	0.0%	0.0%	1.6%	0.0%	6.1%	0	0	16.2%	18.9%	
Shopping (Suntec)	0.12	55.8	51.9	7.1%	0.0%	0.0%	0.9%	0.0%	6.2%	0.06	0	9.9%	11.7%	
University (NUS)	0.21	53.8	51.5	4.2%	0.1%	0.0%	1.2%	0.0%	3.0%	0.02	0	18.1%	20.6%	
Landed (Punggol)	3.74	31.2	13.6	56.3%	0.0%	48.3%	1.4%	4.0%	2.6%	0.91	0.71	200.3%	222.0%	
			Table 1	. Potentia	and drive	ers of AEC	, tor efficie	ncy gain a	and PV ac	option				

Results (Electricity tariff = 60 cents/kWh, feed-in tariff = 8 cents/kWh)

Building	Solar	LCOE (C	ents/kWh)	Total		Incremen	tal reduction	in LCOE		Sell ba grid (I	ack to MWh)	Self-sut (PV ad	ficiency option)	Dynamic
architypes	density (kWp/kWh)	Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
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Condo (Punggol)	0.92	40.8	29.2	28.4%	0.9%	14.7%	4.0%	2.9%	5.9%	1.67	0	53.6%	84.7%	
HDB (Punggol)	1.06	40.7	28.4	30.2%	0.7%	16.4%	3.8%	3.3%	6.0%	1.76	0	51.8%	96.3%	
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University (NUS)	0.21	53.8	51.5	4.2%	0.1%	0.0%	1.2%	0.0%	3.0%	0.02	0	18.1%	20.6%	
Landed (Punggol)	3.74	31.2	13.6	56.3%	0.0%	18 3%	1.4%	4.0%	2.6%	0.91	0.71	200.3%	222.0%	

TADIE T. POLEMILA AND UNVERSIONALG TO EMICIENCY GAIN AND PV ADOPLION

Results (Electricity tariff = 60 cents/kWh, feed-in tariff = 8 cents/kWh)

Building architypes	Solar density (kWp/kWh)	LCOE (Cents/kWh)		Total	Incremental reduction in LCOE					Sell back to grid (MWh)		Self-sufficiency (PV adoption)		Dynamic
		Solar lease	AEC	drop in LCOE	Load pooling	Storage battery	Space Utilization	Demand Flexibility	System Coupling	Solar lease	AEC	Solar lease	AEC	real-time price
Commercial (CBD)	0.13	56.4	53	6.1%	0.1%	0.0%	0.8%	0.0%	5.2%	0.04	0	10.2%	11.9%	
Condo (Punggol)	0.92	40.8	29.2	28.4%	0.9%	14.7%	4.0%	2.9%	5.9%	1.67	0	53.6%	84.7%	
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Industrial (Changi)	0.3	47.5	43.1	9.4%	0.0%	0.0%	2.8%	0.0%	6.7%	0	0	25.4%	29.6%	
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Shopping (Suntec)	0.12	55.8	51.9	7.1%	0.0%	0.0%	0.9%	0.0%	6.2%	0.06	0	9.9%	11.7%	
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Table 1. Potential and drivers of AEC for efficiency gain and PV adoption

Discussion

- **Residential communities** have high potential (high solar density).
- Electricity tariff needs to rise to fully reflect the carbon emission cost of fossil-fuel-based electricity generation, so that to provide incentive to BESS.
- Demand management is needed, system coupling (with district cooling) also helps.
- Potential improvement in **space utilization** for BIPV deployment, hence raising solar density.

Future extension

Allowing heterogeneous demand flexibility among AEC participants

To investigate the potential for more flexible users to contribute to AEC performance (by reducing the optimal BESS capacity).

Between AEC P2P trade

To investigate the mechanism for residential AEC (with day-time energy surplus) to trade with non-residential AEC (with day-time energy deficit) to reduce the optimal BESS capacity.

AEC Business model design

The internal dynamic pricing provides the incentive for optimal user load scheduling to reduce the community LCOE. The surplus from the reduced LCOE needs to be properly divided among the AEC participants to create efficient participation incentives.

Thank you!