

Yes, Look Up!

High Temperature / Low Sag Conductors for
increased capacity, higher efficiency, climate
mitigation and climate resilience

Dan Millison

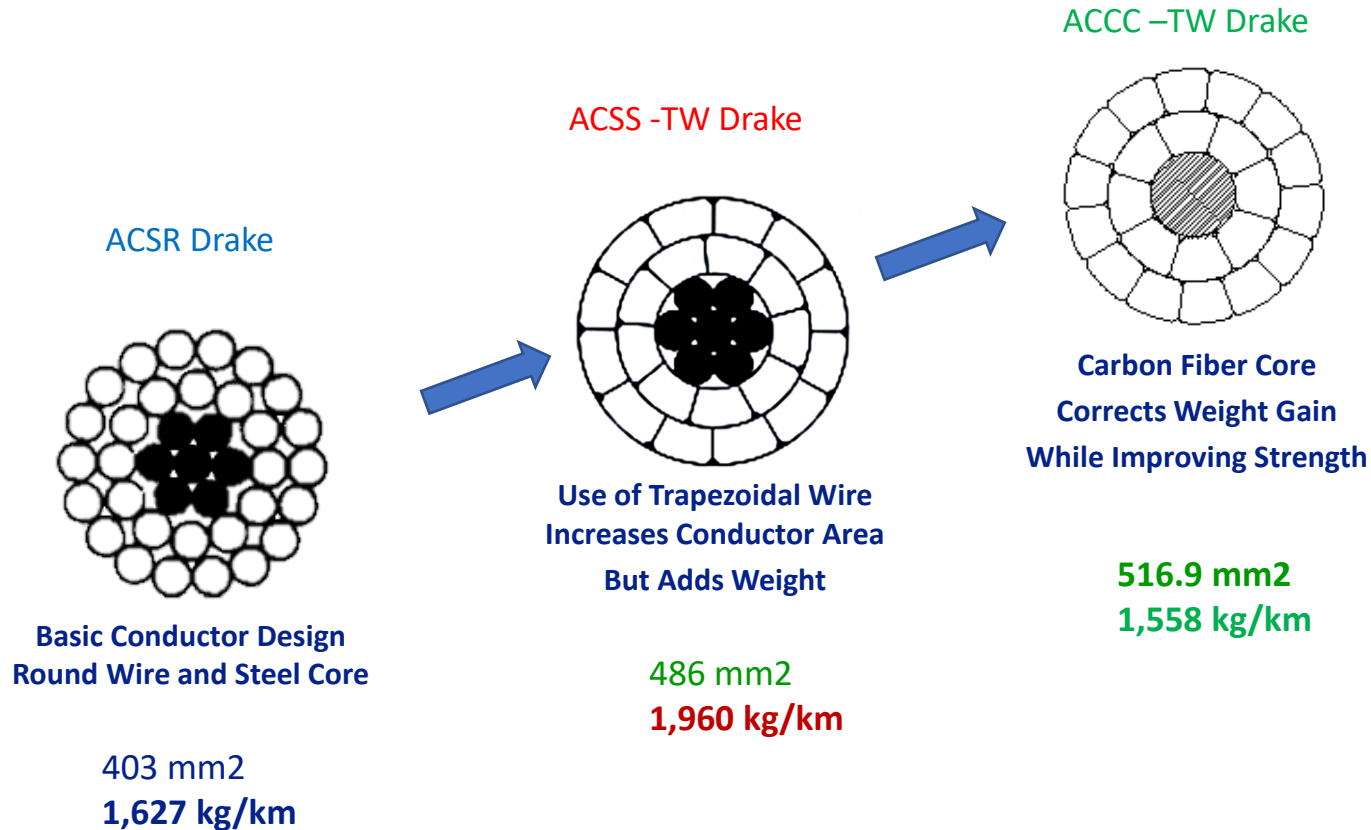
Delta C, LLC

Asia Clean Energy Forum, June 2023

Evolution of conductor design and performance

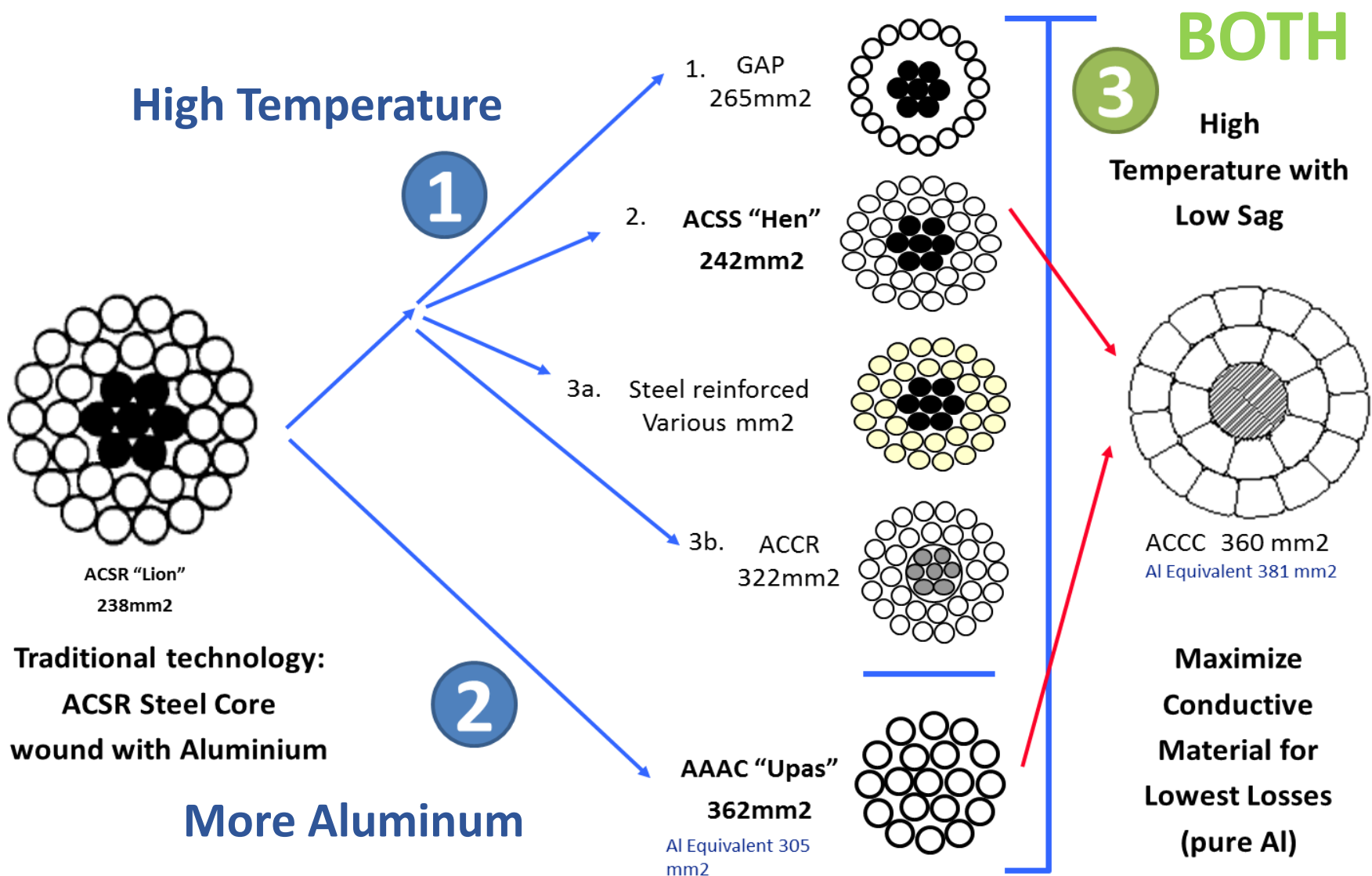
ACCC[®] conductors combine annealed aluminum with high temperature composite technology and an increased aluminum cross sectional area

ACSR introduced when Thomas Edison was still alive

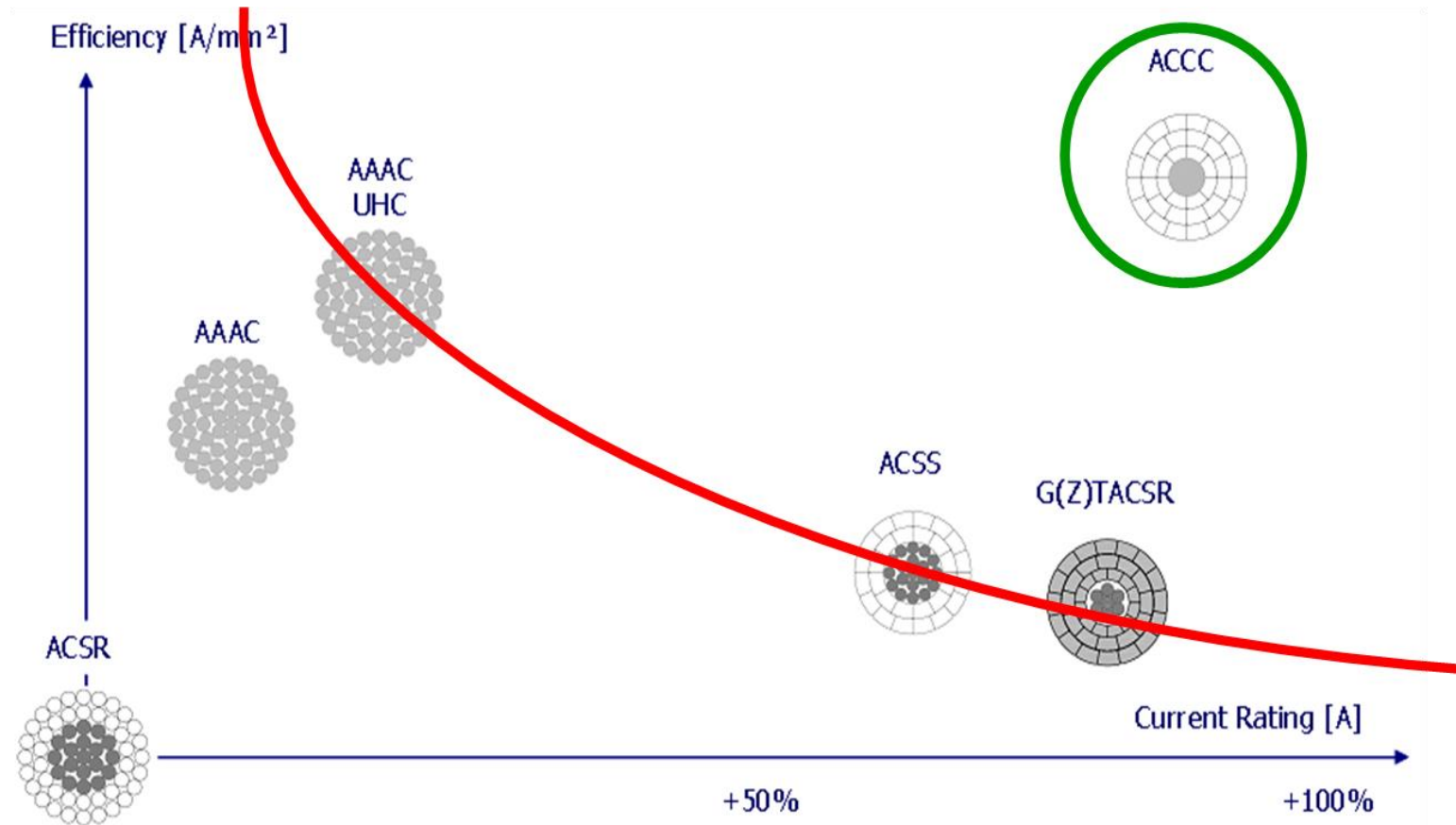


HTLS / ACCC[®] is a 21st century solution for 21st century challenges

High Temperature Low Sag (HTLS) conductors – several options available

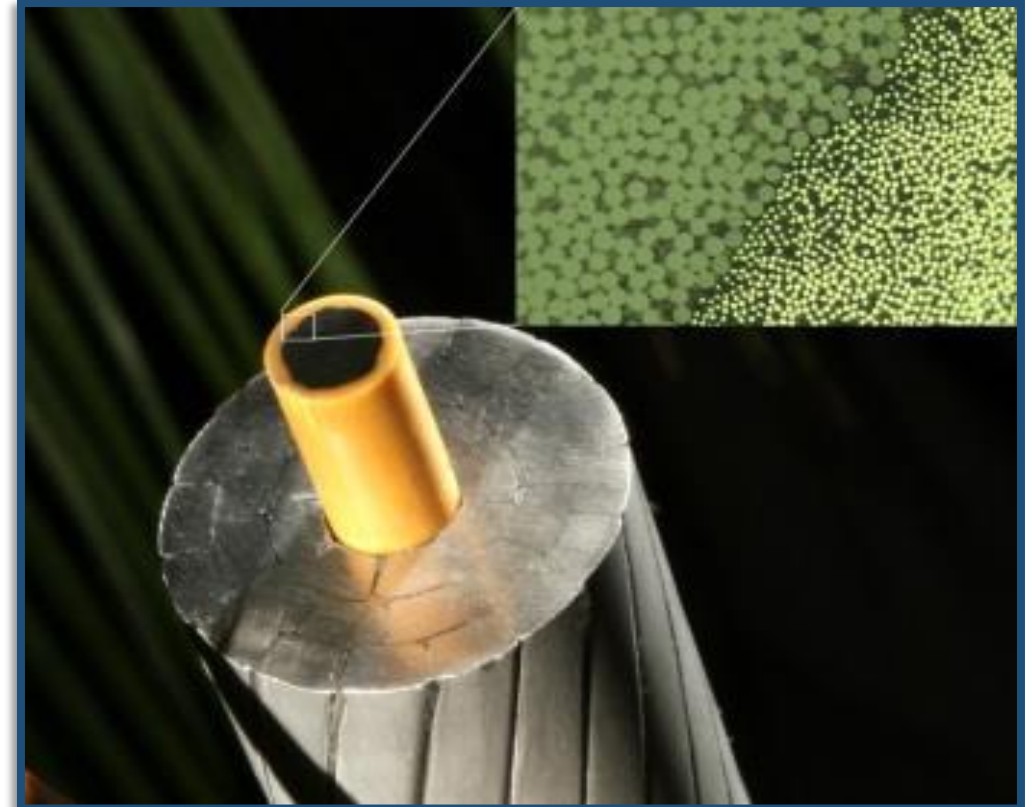
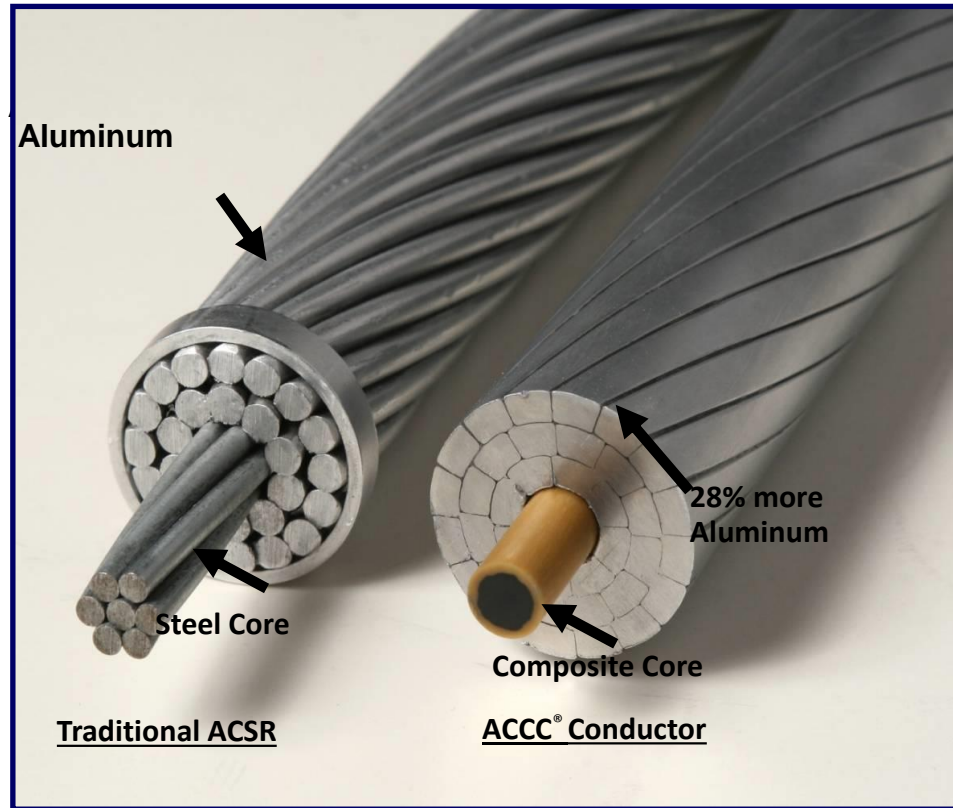


1st Philippines project using ACCC[®]: ACCC[®] selected for increased capacity + efficiency



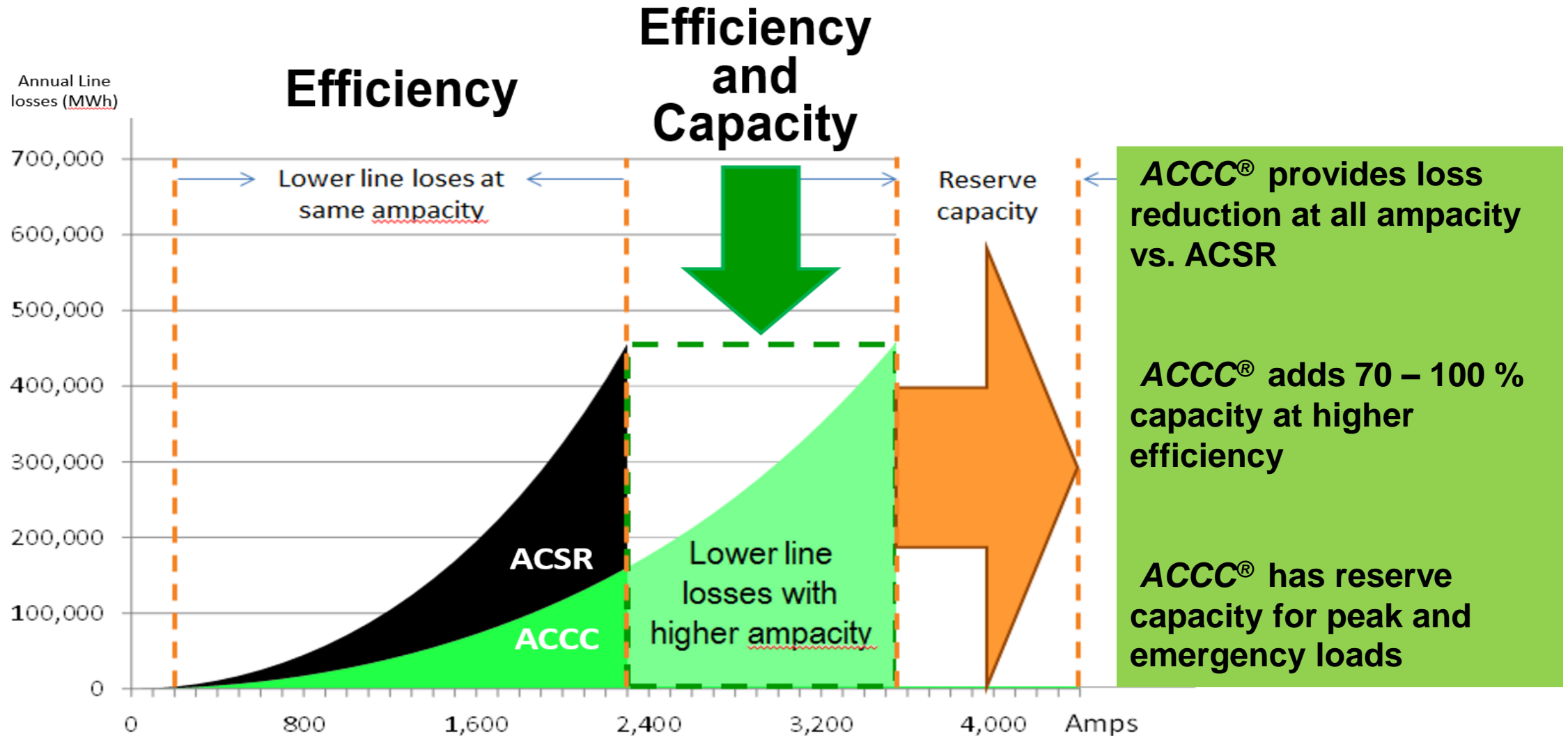
ACCC Conductors combine efficiency and increased current carrying capacity to deliver more power with less losses based on equal conductor size and weight.

ACSR vs. ACCC[®] Conductor



ACCC hybrid carbon fiber core is 70% lighter and 50+% stronger than steel but has a coefficient-of-thermal-expansion about 10 times less than steel. This allows the use of 28% more aluminum which helps increase capacity, improve efficiency & mitigate thermal sag. ***Available for 11 kV and higher.***

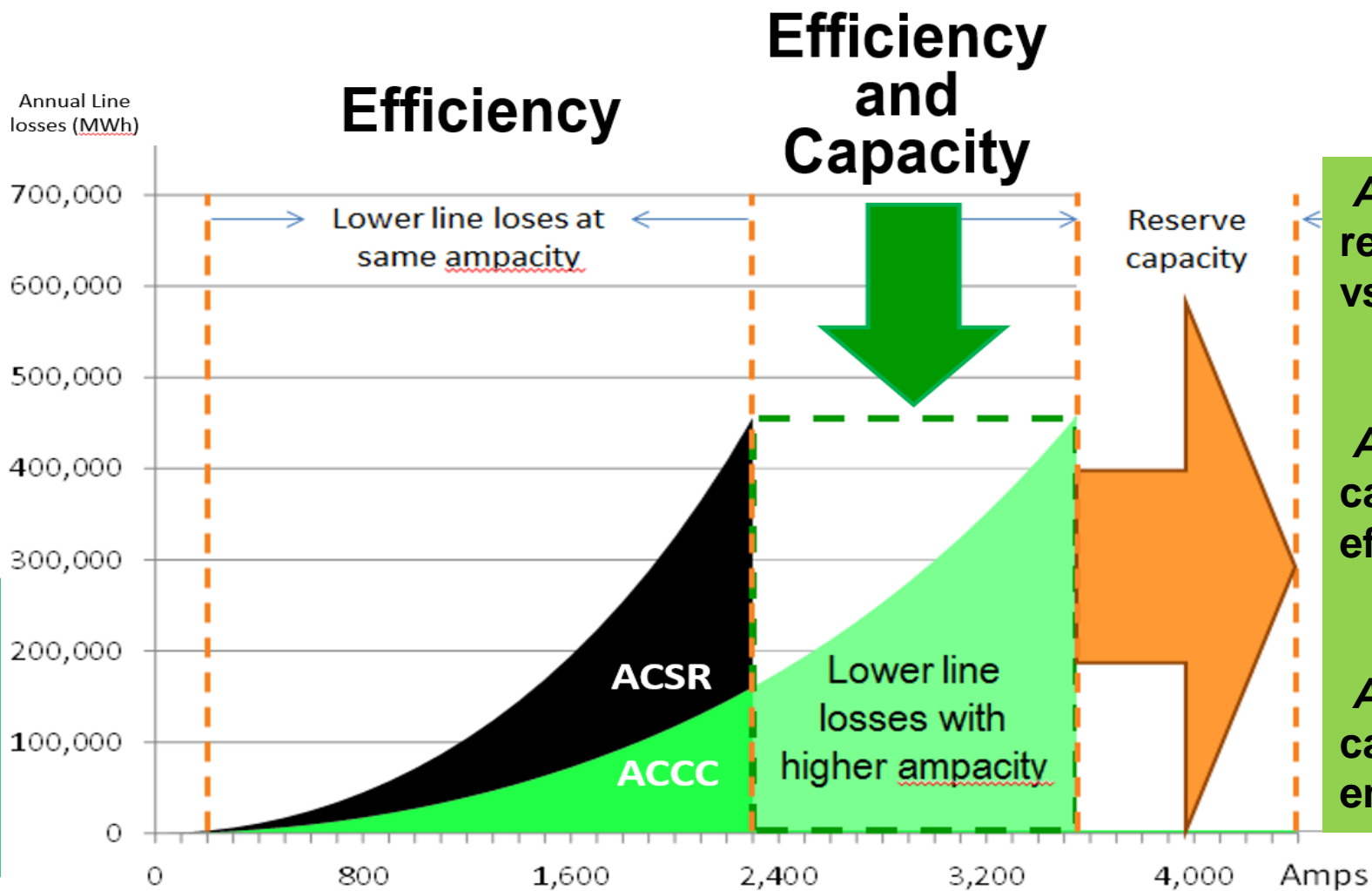
Efficiency (\$\$ savings) + Capacity (\$\$ revenue)
= effective reduction in GHG intensity (\$\$ carbon revenue)



Capacity + Efficiency = effective reduction in GHG intensity *

150,000
MWh/y
savings

@
\$50/MWh
=
\$7.5+
Million/y



ACCC® provides loss reduction at all ampacity vs. ACSR

ACCC® adds 70 – 100 % capacity at higher efficiency

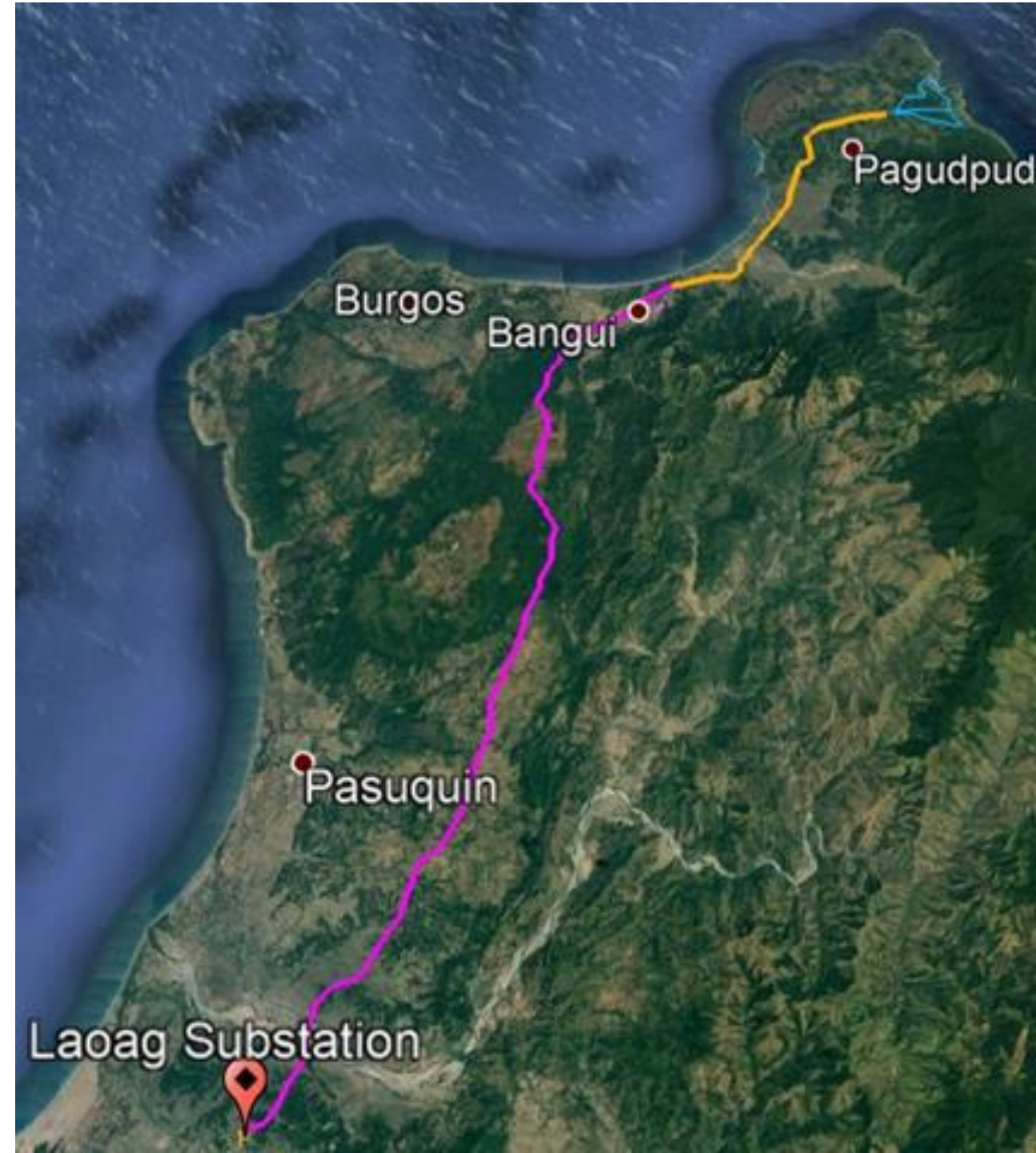
ACCC® has reserve capacity for peak and emergency loads

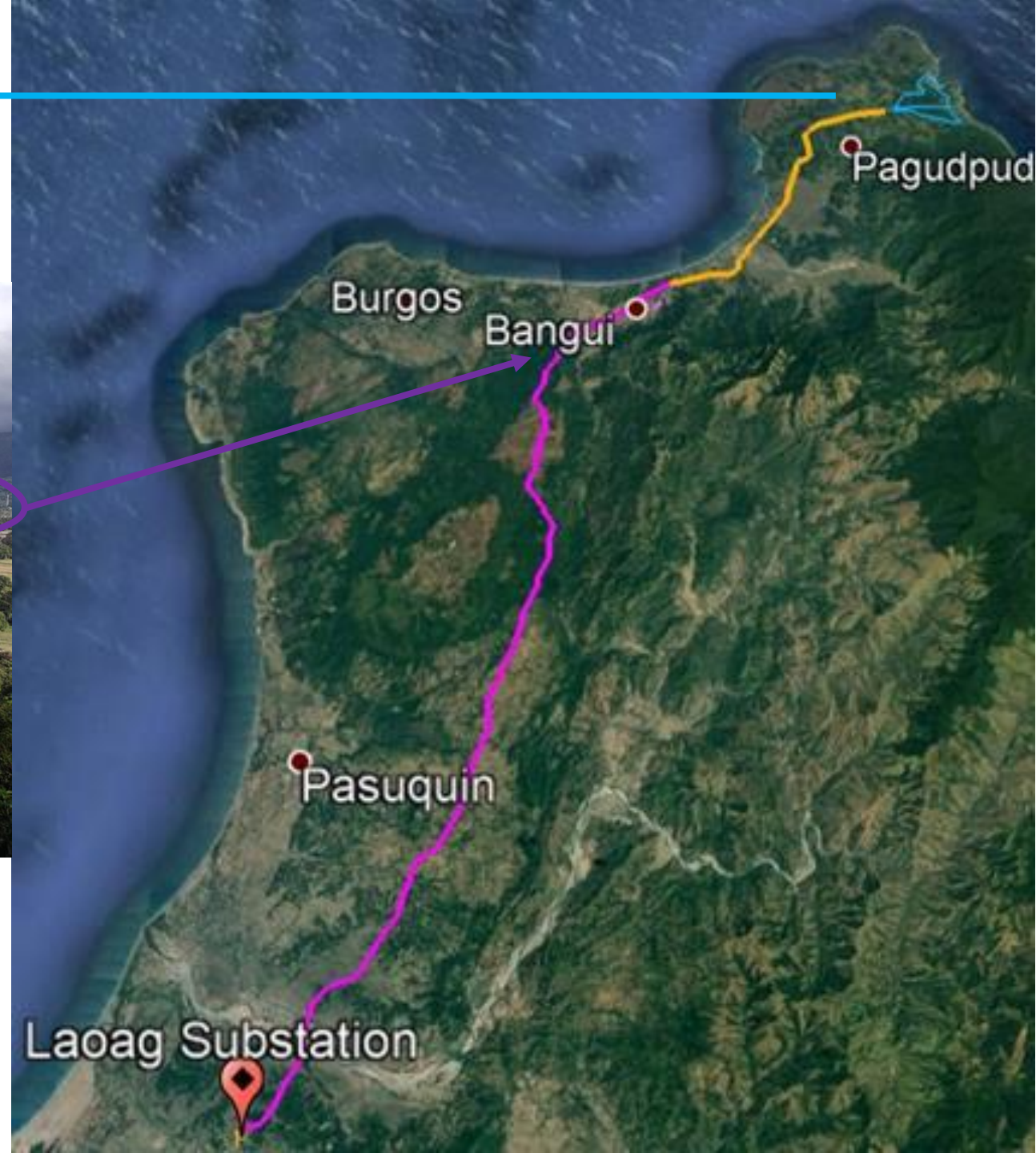
* CDM methodology for carbon \$\$\$

Philippines 1st installation* of ACCC[®]

- Upgrade of existing 115 kV double circuit line to accommodate wind power expansion from 81 MW to 241 MW
- ***Upgradable to 230 kV***
- No new right-of-way required
- ~ 40 route kilometers
- 240 km of conductor
- Total cost of upgrade ~ \$5 million (?)

* More than 100,000 km of ACCC[®] has been installed on more than 1000 projects worldwide





5 minute feasibility study

Match diameter and weight



ACSR capacity at rated temperature 75 C = 883 Amps

ACCC® capacity at rated temperature 180 C = 1812 Amps

Higher capacity possible if line is upgraded to 230 kV

	Base Conductor	Comparison Conductor #1
Type	ACSR	ACCC®
Size (Unit - Code Word)	795 kcmil CONDOR	983 kcmil CONDOR (60 Hz)-PREL.
Aluminum Area (mm ²)	402.8	498.2
Diameter (mm)	27.762	27.737
Rated Strength (kN)	125.4	181.9
Weight (kg/km)	1,523.6	1,510.5
DC Resistance at 20°C (ohms/km)	0.0705	0.0562
AC Resistance at 25°C (ohms/km)	0.0728	0.0585
AC Resistance at 75°C (ohms/km)	0.0894	0.0697
Conductors per phase	1	1
Number of Circuits	1	1
Ampacity (A) at Rated Operating Temp (°C)	(75) - 883	(180) - 1,810
Ampacity (A) at Maximum Temp (°C)	(100) - 1,115	(200) - 1,912
Ampacity (A) at Temperature (°C)	(60) - 686	(60) - 774
Ampacity (A) at Temperature 2 (°C)	(75) - 883	(75) - 1,000
Ampacity (A) at Temperature 3 (°C)	(90) - 1,032	(90) - 1,172
Solar Absorptivity	0.50	0.50
Emissivity	0.50	0.50

5 minute feasibility study

1st year line loss savings
@ \$50 / MWh
= \$3.1 Million
Simple payback less than
2 years

*Avoided GHG emissions of
39,000 tons CO₂e / year
@ \$50 / ton CO₂e
= \$1.95 million / year*

Line Losses (42.00 km, 1766 Peak Amps)		
Steady-State Temperature (°C) at Peak Ampacity	229	172
Resistance at Peak Operating Amps (ohm/km)	0.14038	0.09130
First Year Line Losses (MWh)	182,063	118,410
Difference in First Year Line Losses vs Base Conductor(MWh)	--	-63,653
% Difference in First Year Line Losses vs Base Conductor (%)	--	-35 (%)
First Year Line Loss Savings vs. Base Conductor Base Conductor (USD/Year)	--	3,182,639
Line Loss Savings per meter of Conductor vs Base Conductor (USD/m/Year)	--	25.26
30 year Line Loss Savings vs Base Conductor (USD)	--	95,479,167
Difference in First Year CO ₂ Generated vs Base Conductor (MT)	--	-39,592

Value proposition for 30 year operating lifetime:

\$95+ Million in line loss savings @ \$50 / MWh + \$58.5 Million in avoided GHG emissions
\$152.5 Million / \$5 million investment => 30 to 1 return

Carbon markets should be paying for this, but...

New ACCC[®] Condor

*Some special handling
required + hardware
replacement for higher
operating temperature*

Existing ACSR
795 Condor



Implications for ADB / Asia's Climate Bank

- ~ **50% of sovereign energy investments are in T & D systems**
 - CDM methodology available and applied to Bangladesh PGCB project funded by ADB & AIIB, with co-financing from Japan Fund for Joint Crediting Mechanism (JFJCM) in 2018
 - Higher wind loading = climate resilience
 - Higher operating temperature (180 C vs. 75 C) = climate resilience
 - **ACCC® projects are climate change mitigation + adaptation projects**
- ACCC® conductors available for 11 kV and higher ratings
 - Upgrade market in ADB DMCs ~ \$1 Billion / year (?)
- No concessional finance required (some exceptions might exist)
- No civil works = environment Category C or B
- No involuntary resettlement = Category C
- No impacts on indigenous peoples = Category C



No Transmission - No Transition

Thank you!

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