

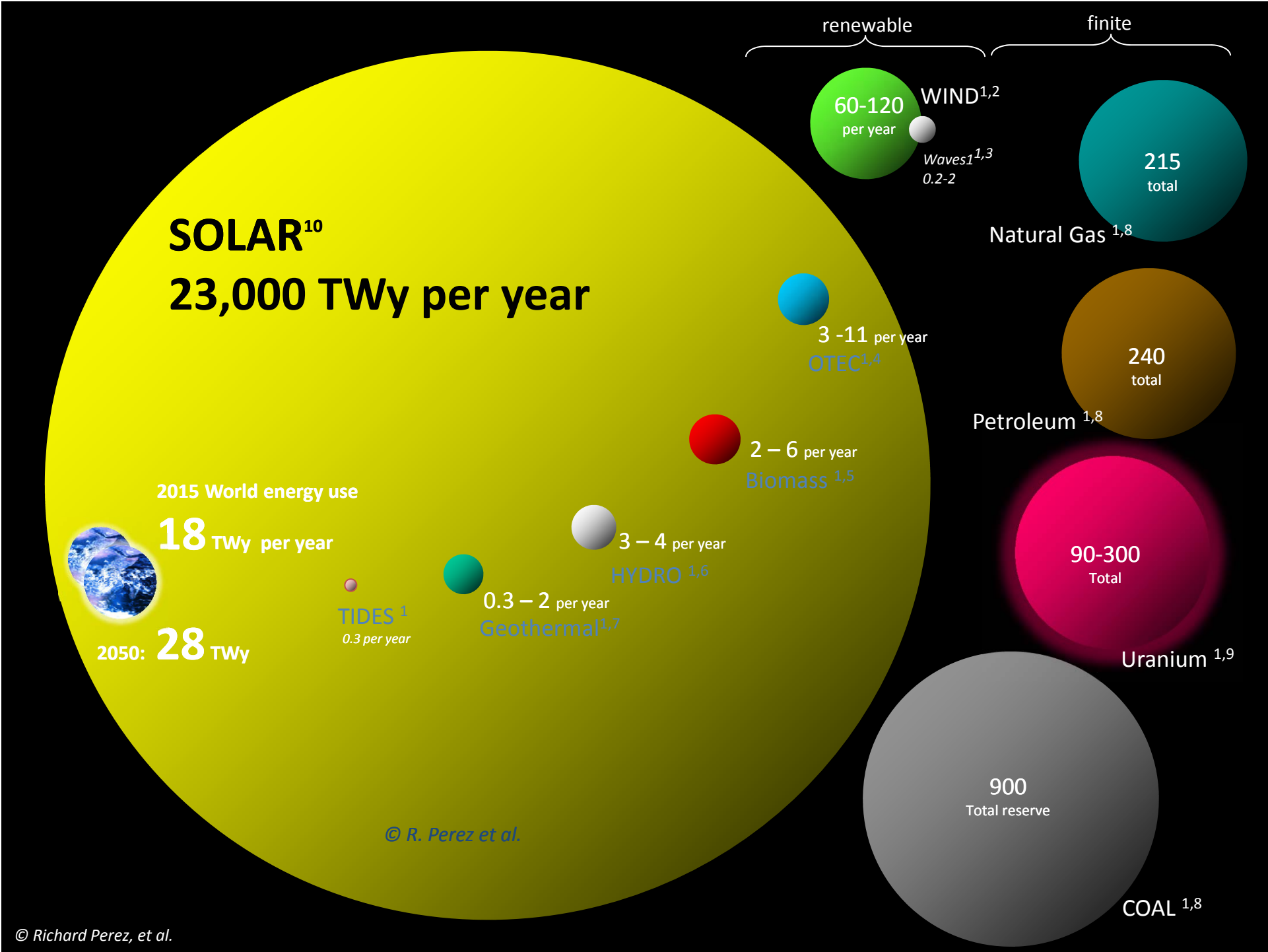
BIG SOLAR

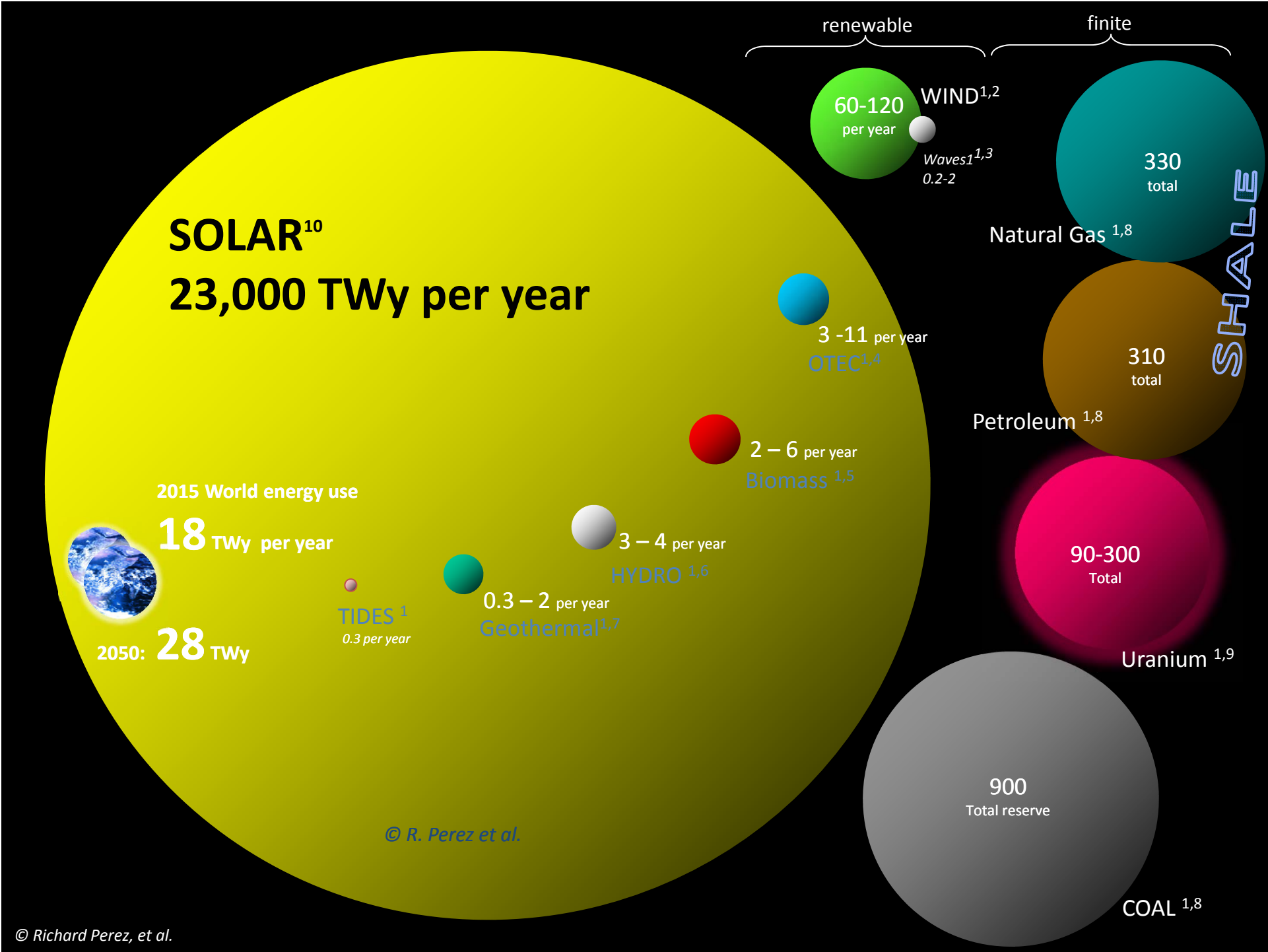
Procuring 100% of our energy from the sun is both reliable and affordable

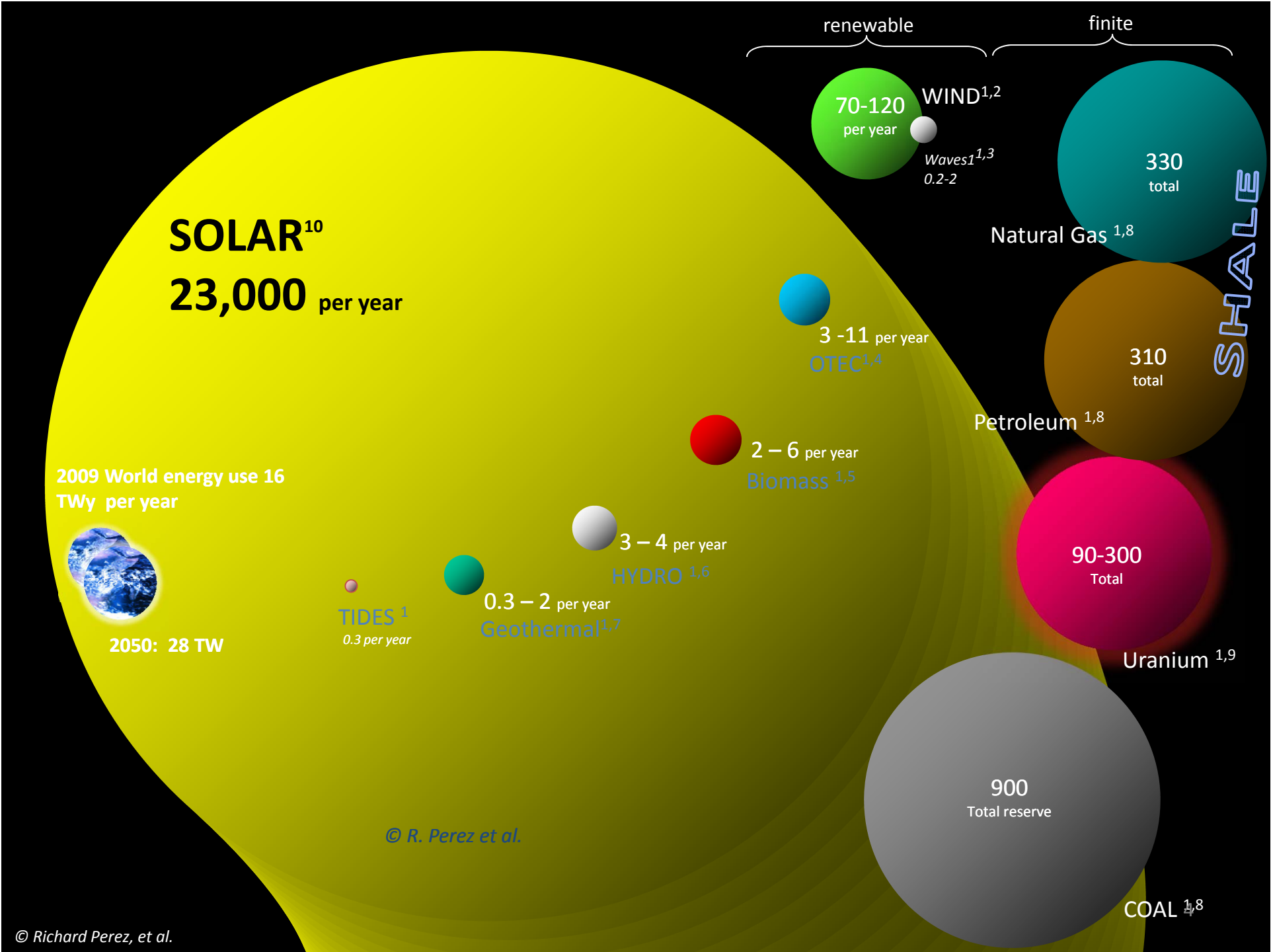
Richard Perez

ASRC, University at Albany

www.asrc.cestm.albany.edu/perez/

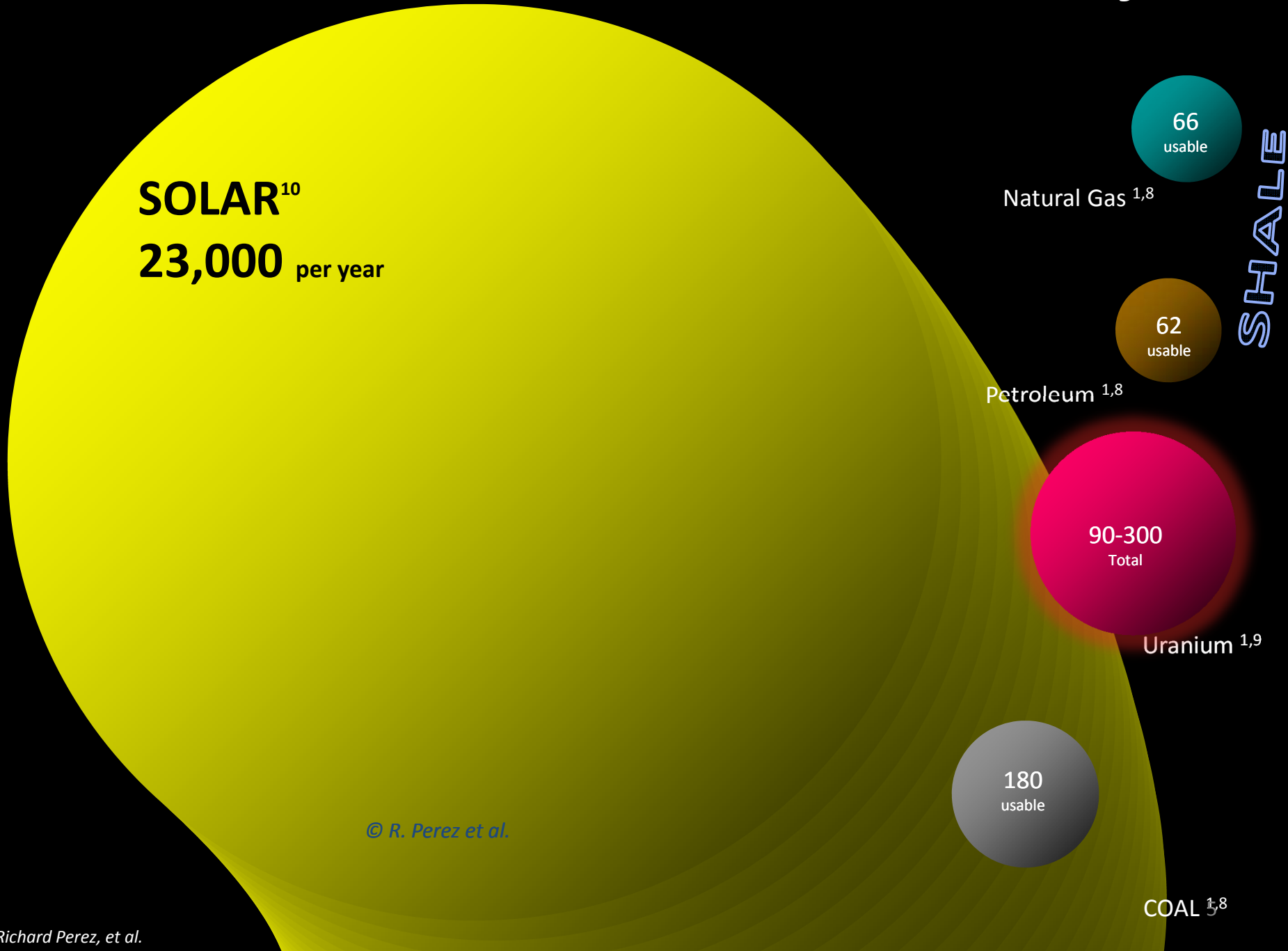






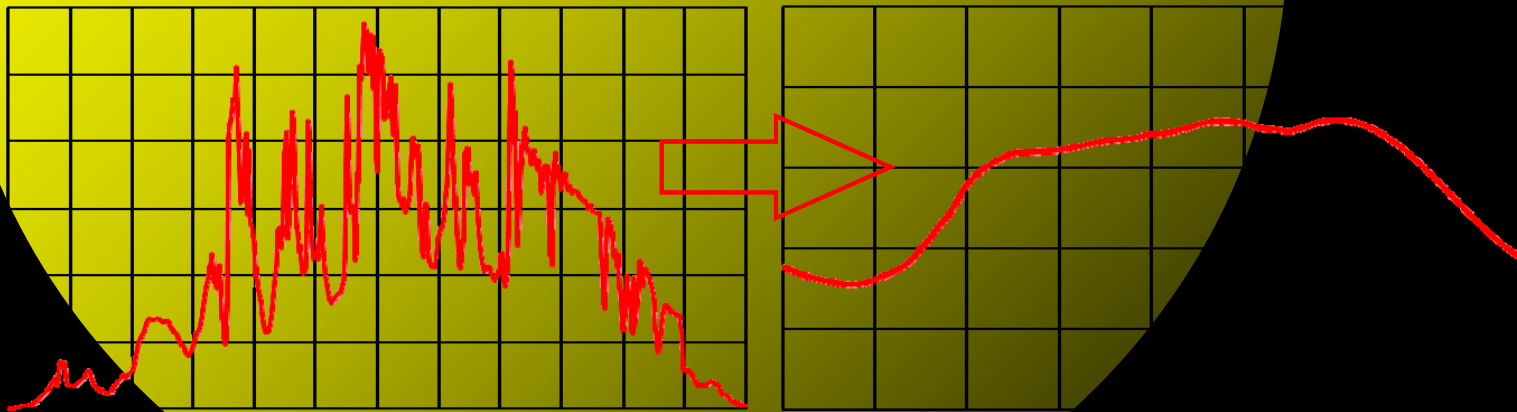
© R. Perez et al.

COP 21: We must leave 80% of fossil in the ground

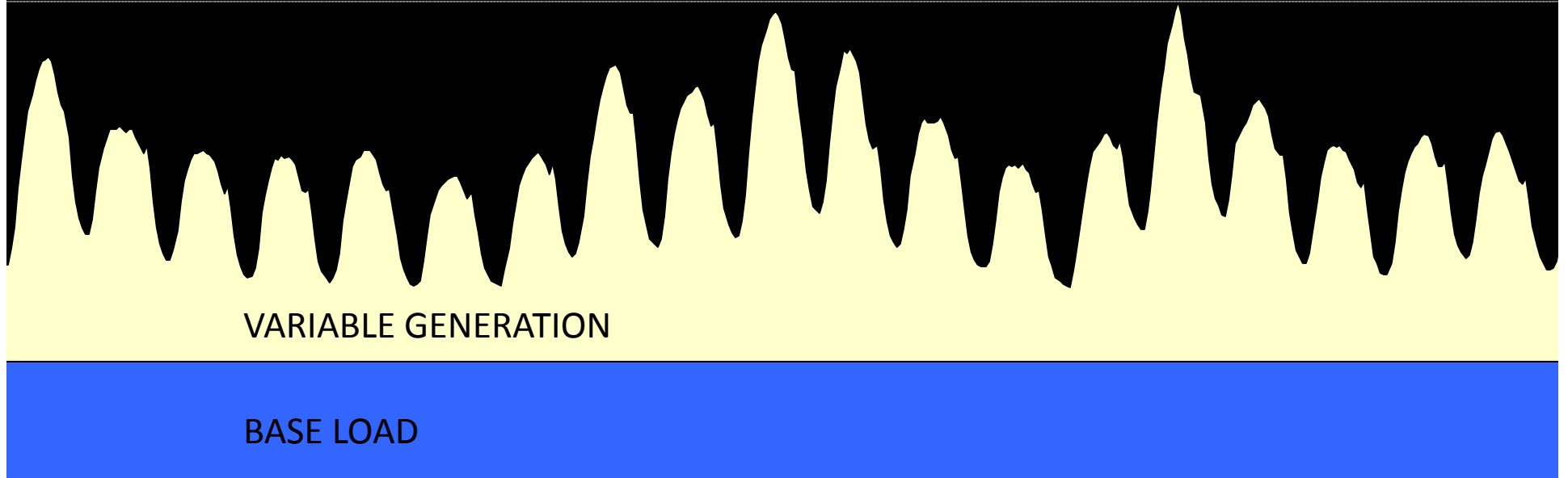


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INTERMITTENT SOLAR

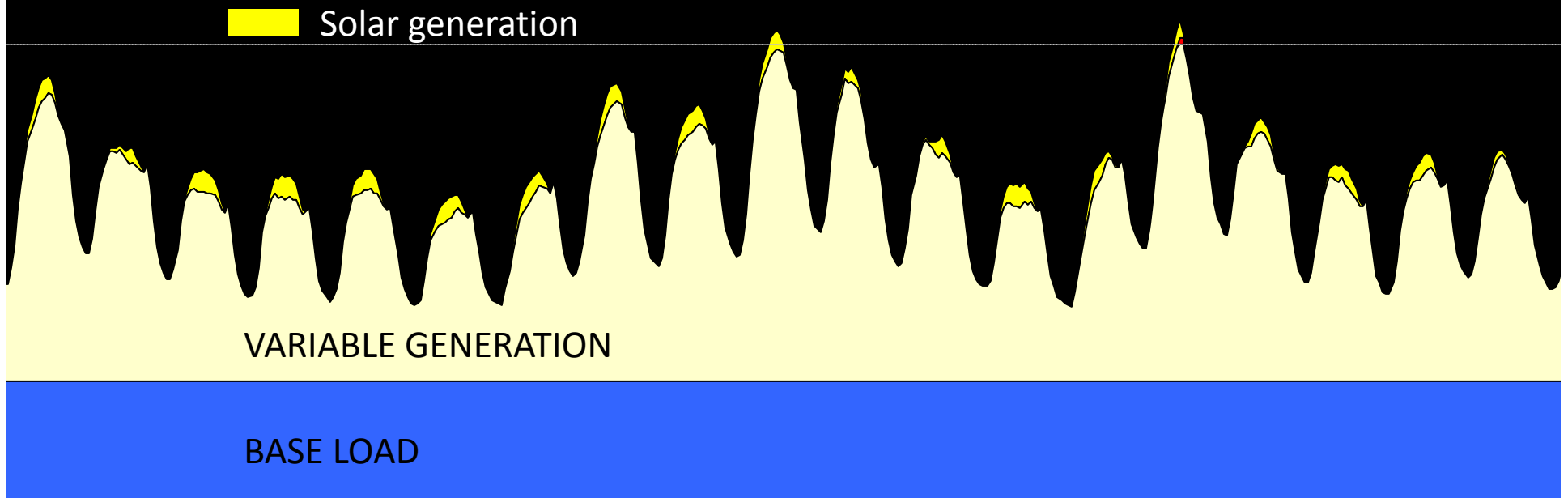


New York City electrical demand



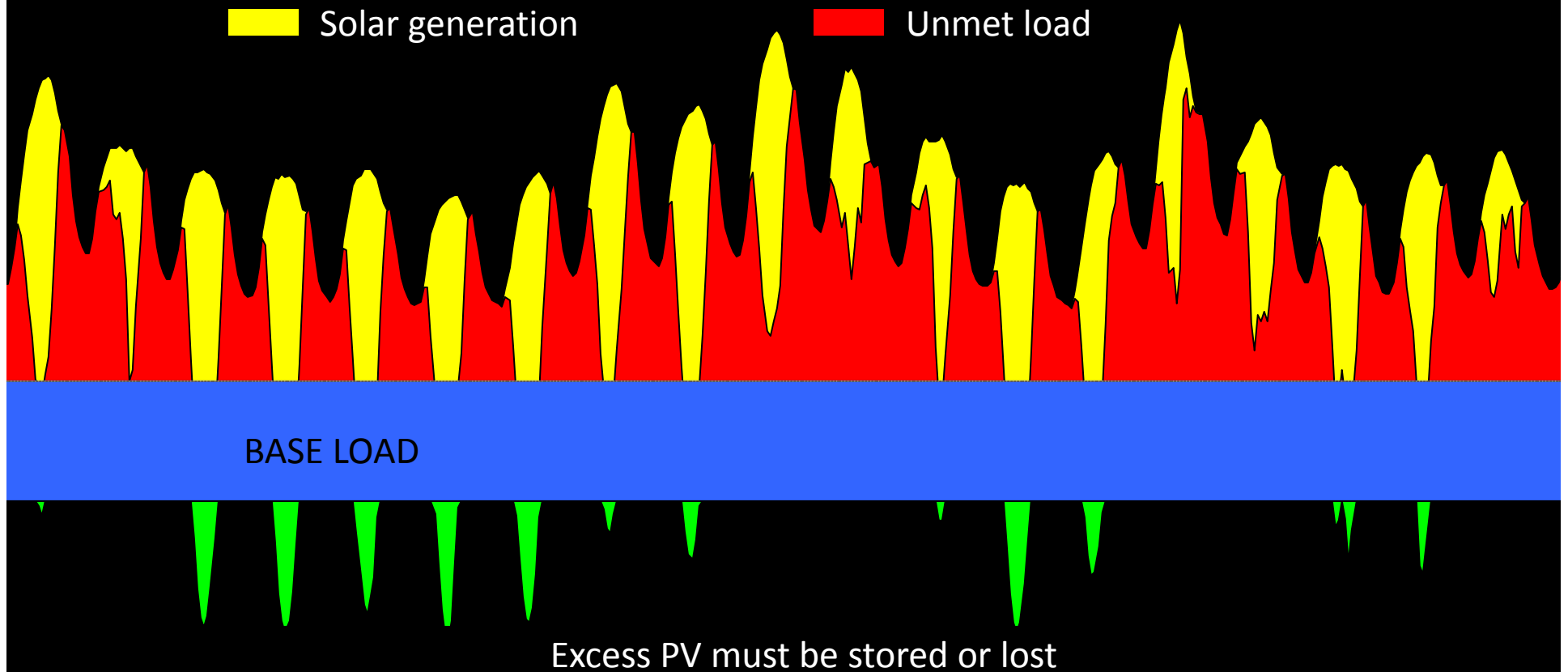
New York City electrical demand

Low penetration solar: **very effective**



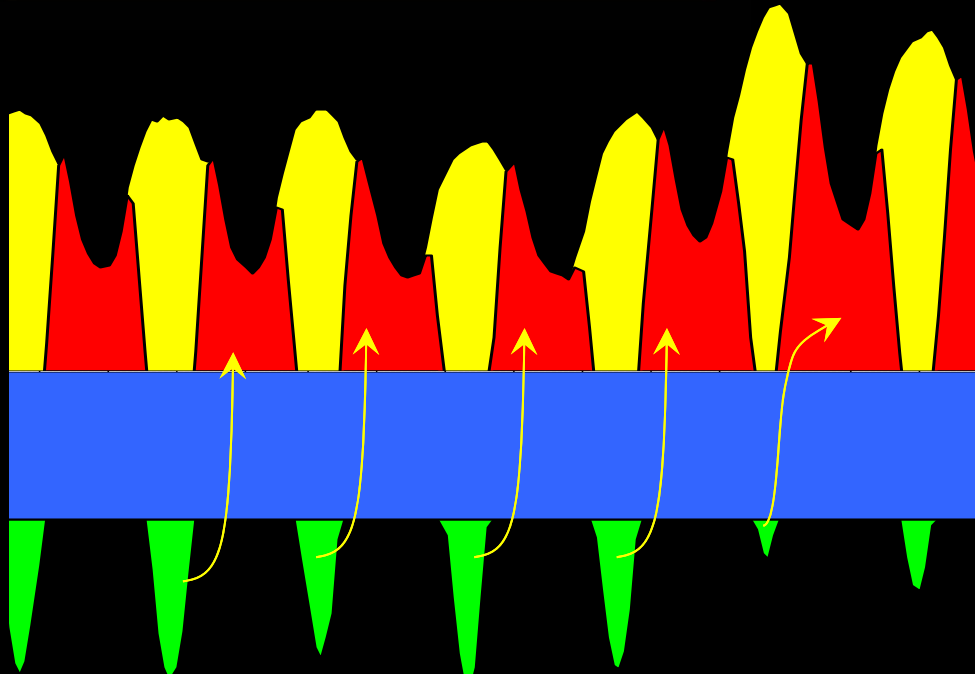
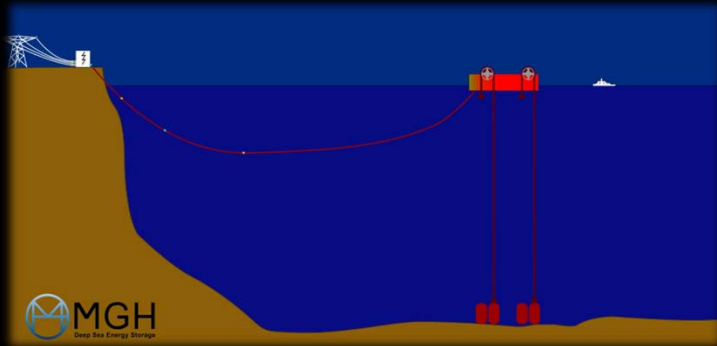
New York City electrical demand

High penetration solar: **Problems**

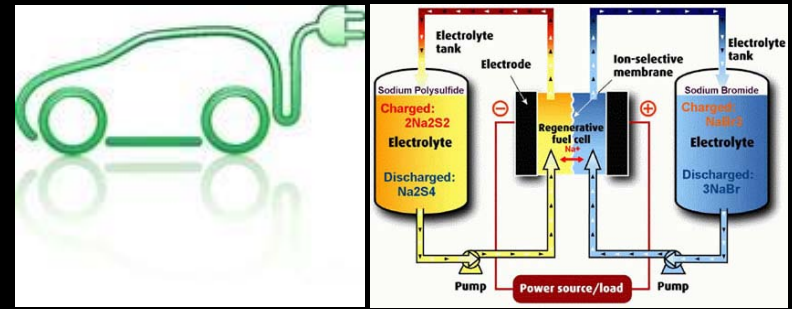


VERY HIGH PENETRATION SOLUTIONS

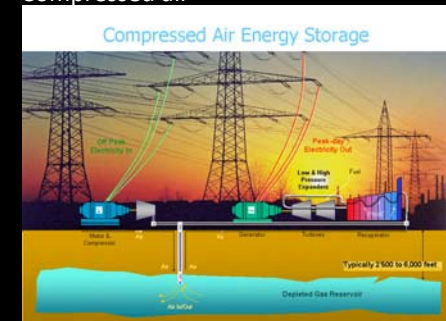
1. STORAGE



Batteries & Flow batteries

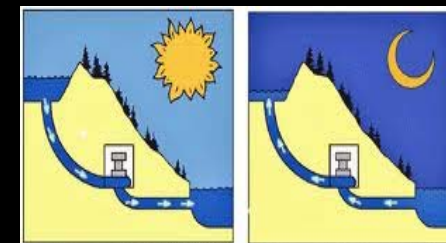


Compressed air



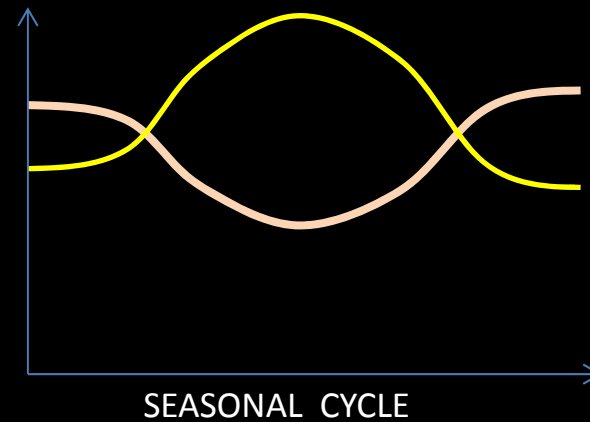
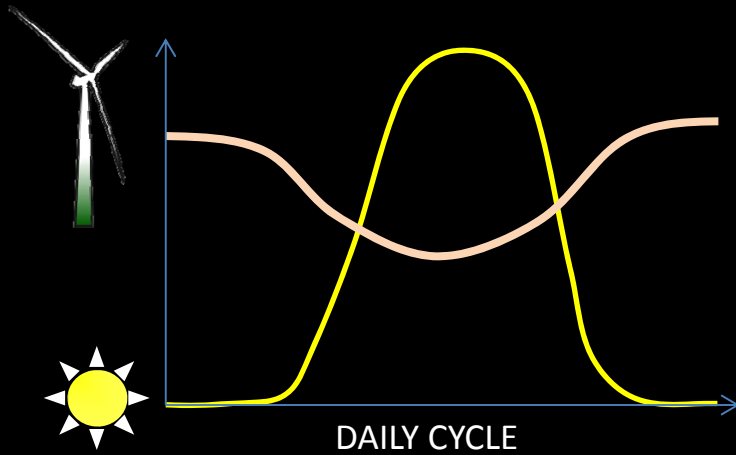
H₂

Pumped hydro & gravity



1. STORAGE

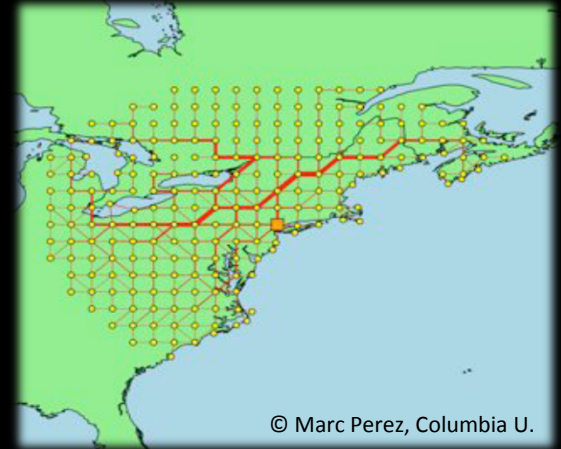
2. SYNERGY W/WIND

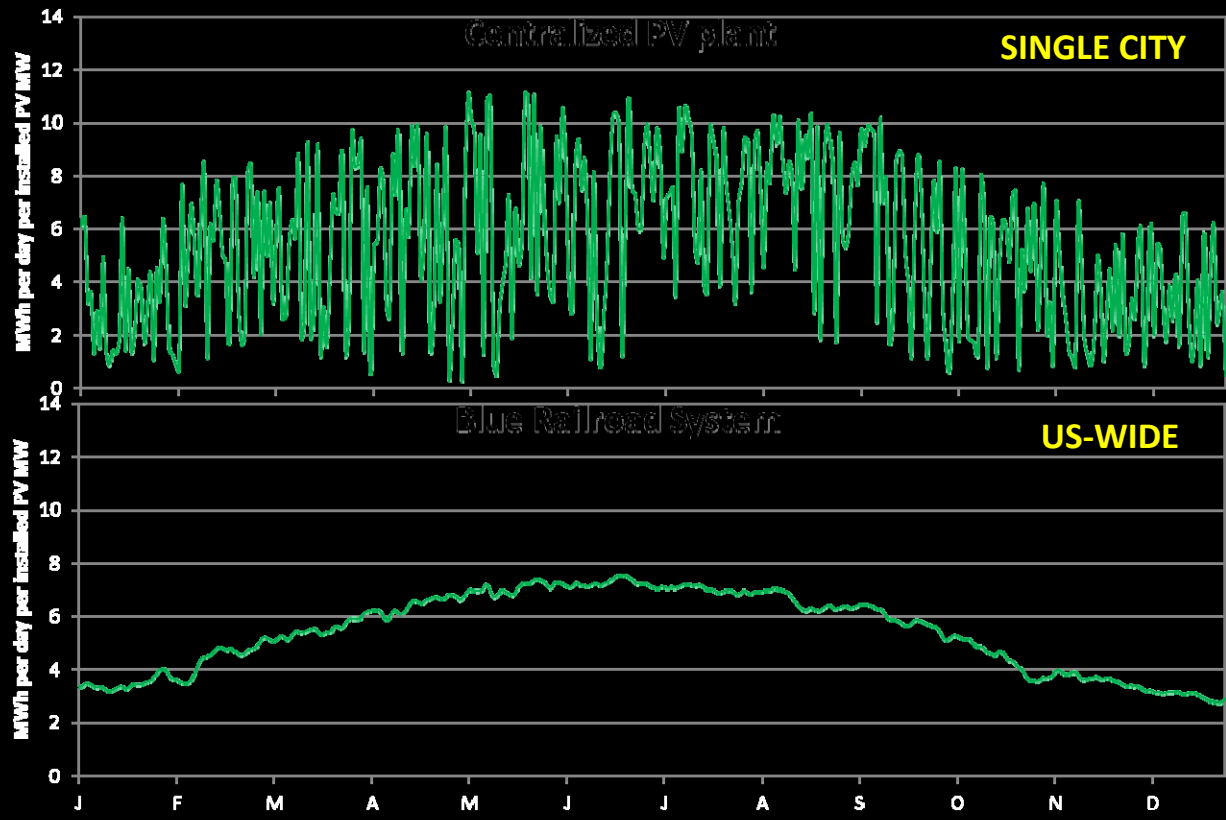


1. STORAGE

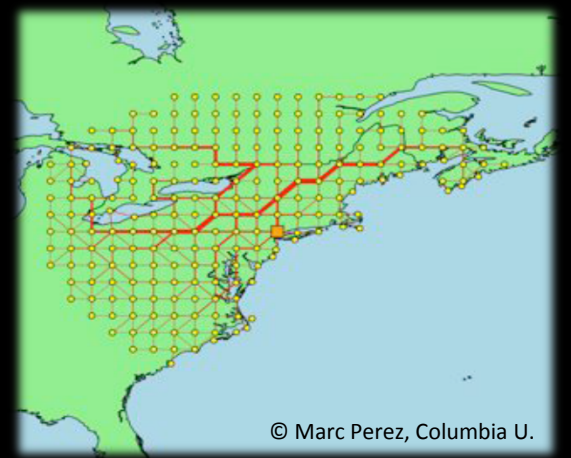
2. SYNERGY W/WIND

3. INTERCONNECTION





Source: Marc Perez, Columbia University



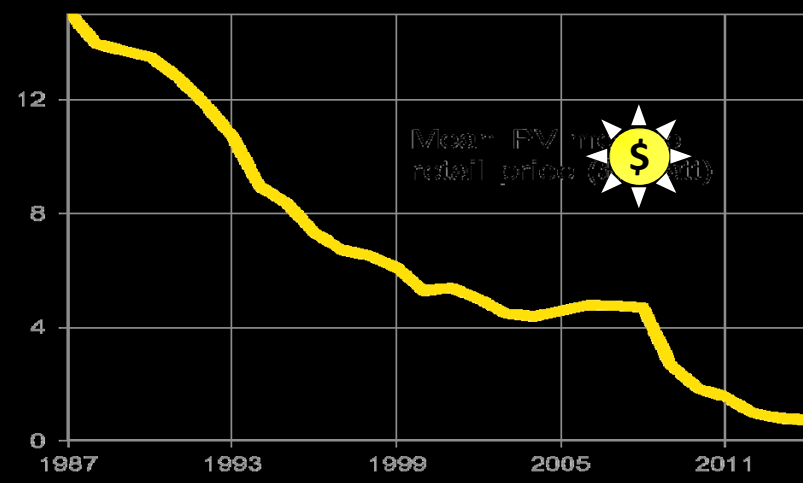
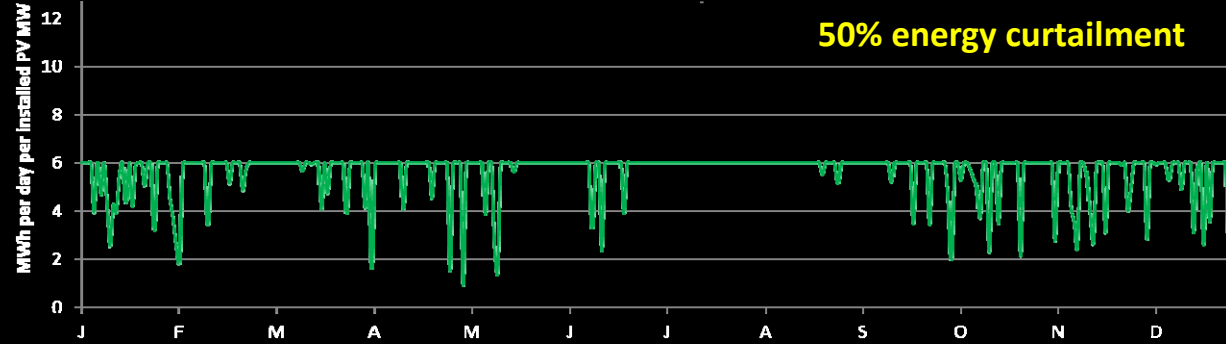
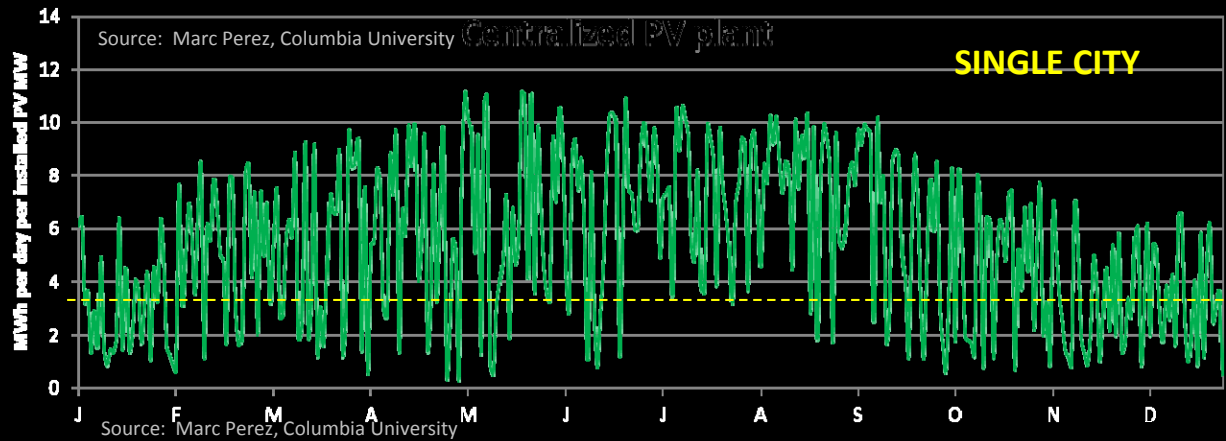
© Marc Perez, Columbia U.

1. STORAGE

2. SYNERGY W/WIND

3. INTERCONNECTION

4. CURTAILMENT



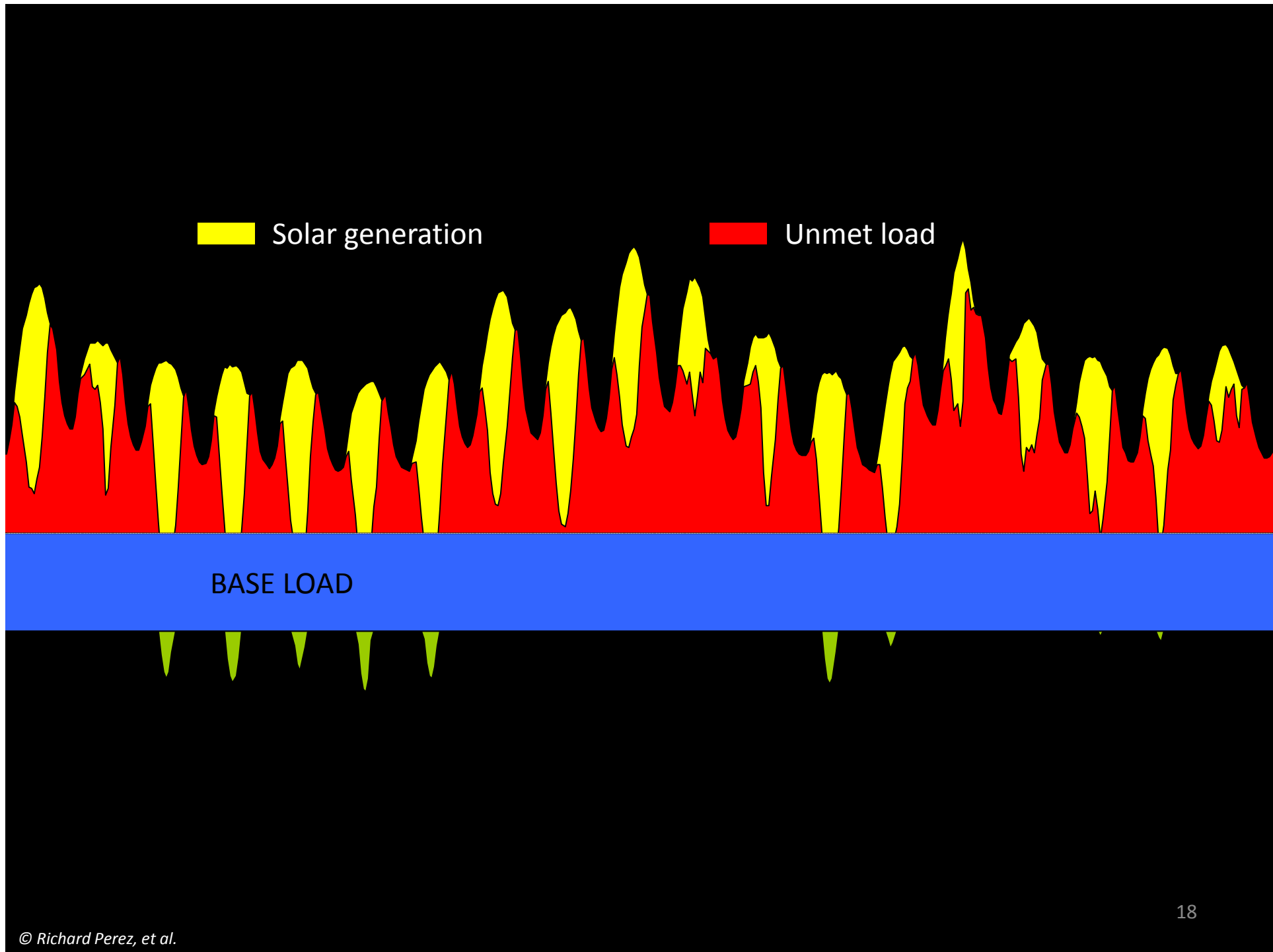
1. STORAGE

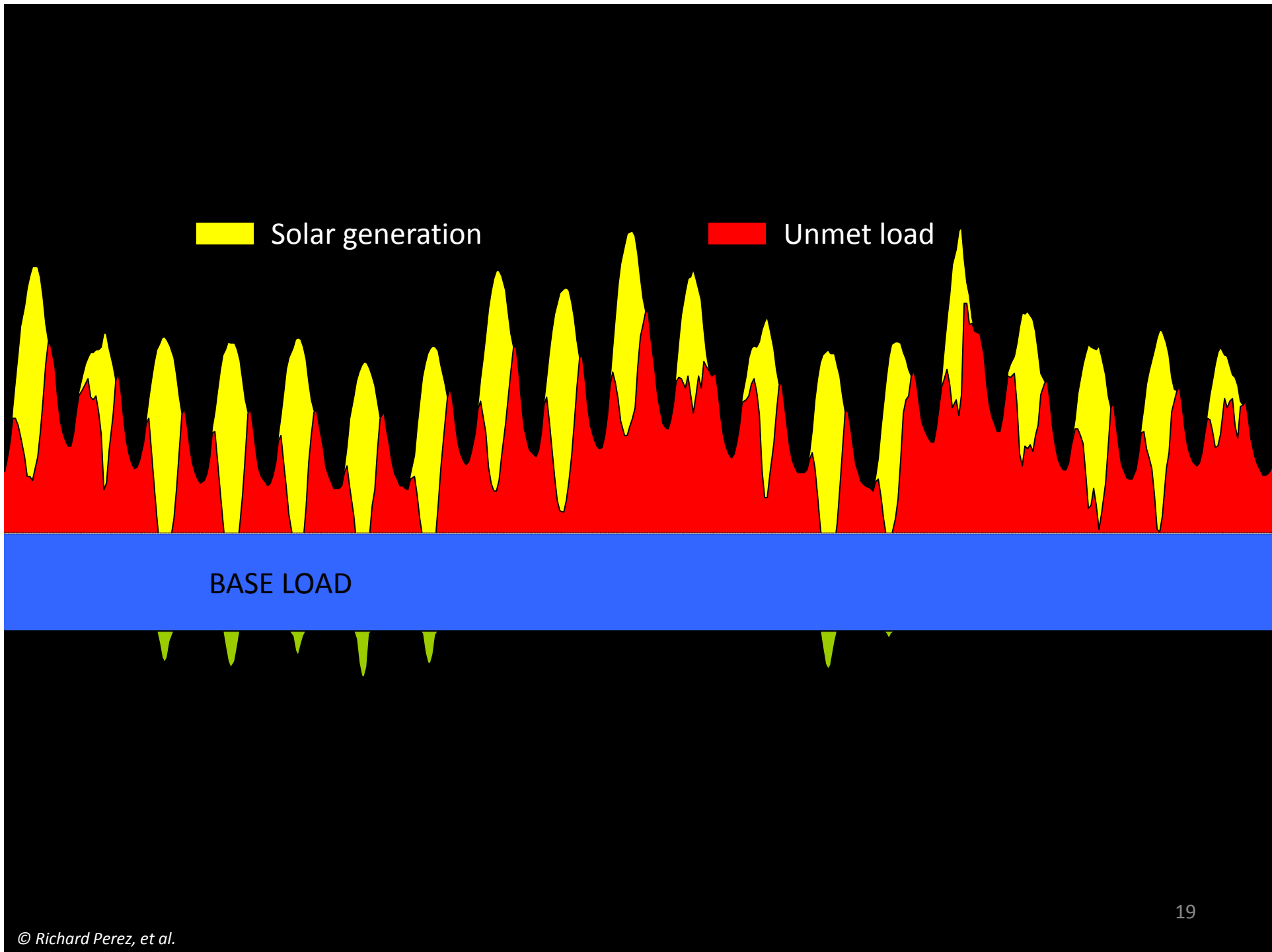
2. SYNERGY W/WIND

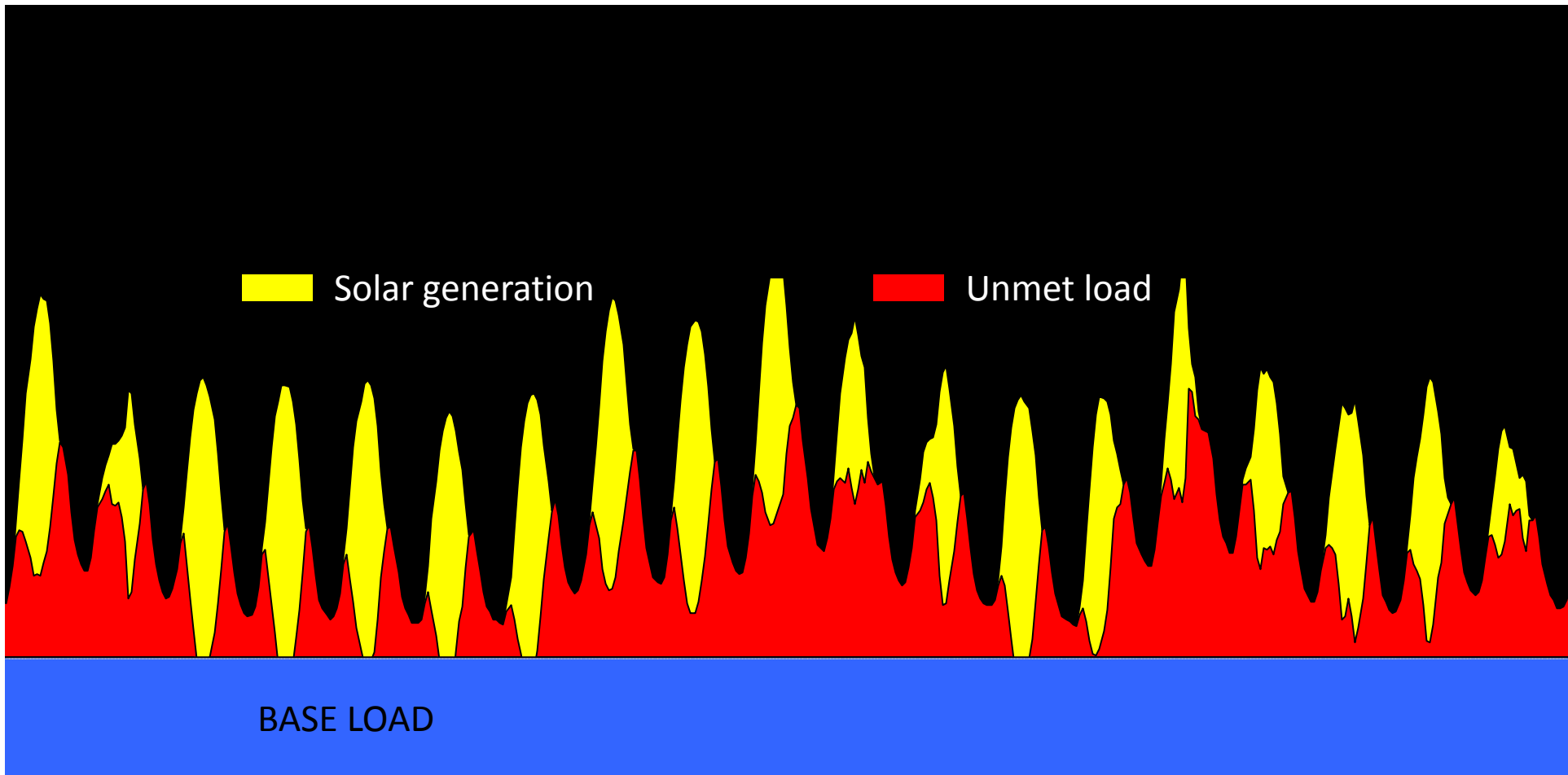
3. INTERCONNECTION

4. CURTAILMENT

5. LOAD SHAPING



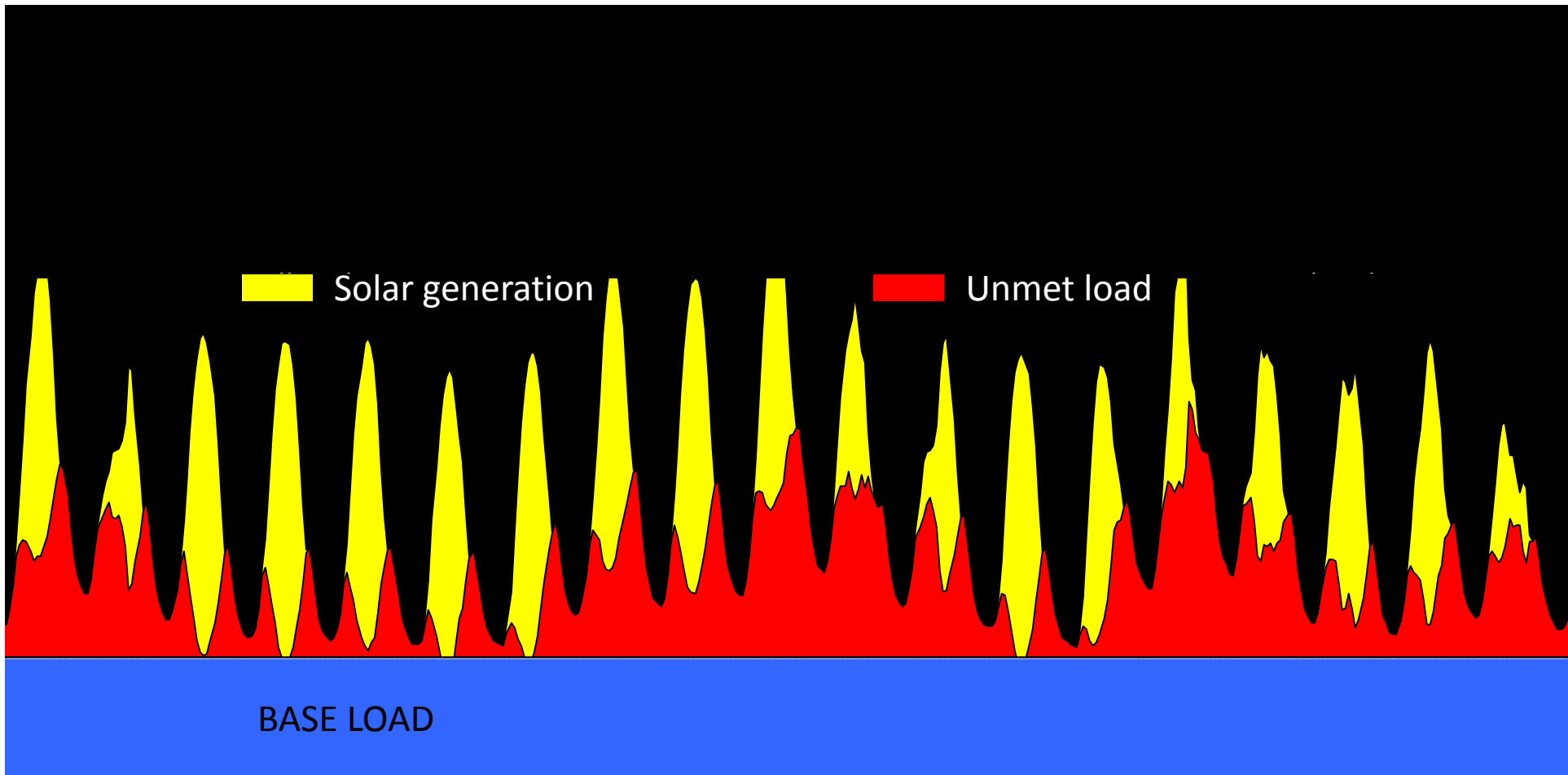




■ Solar generation

■ Unmet load

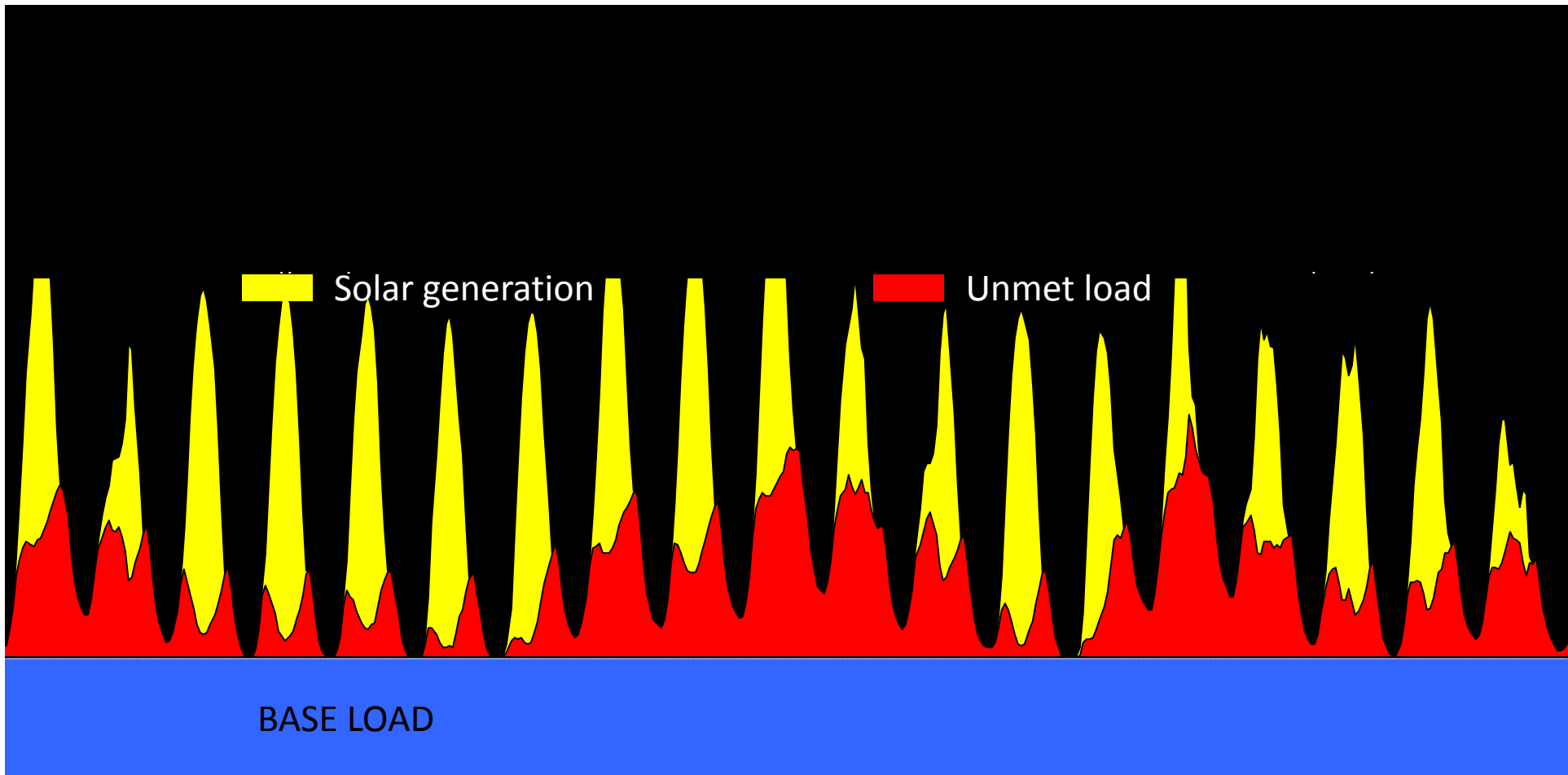
BASE LOAD

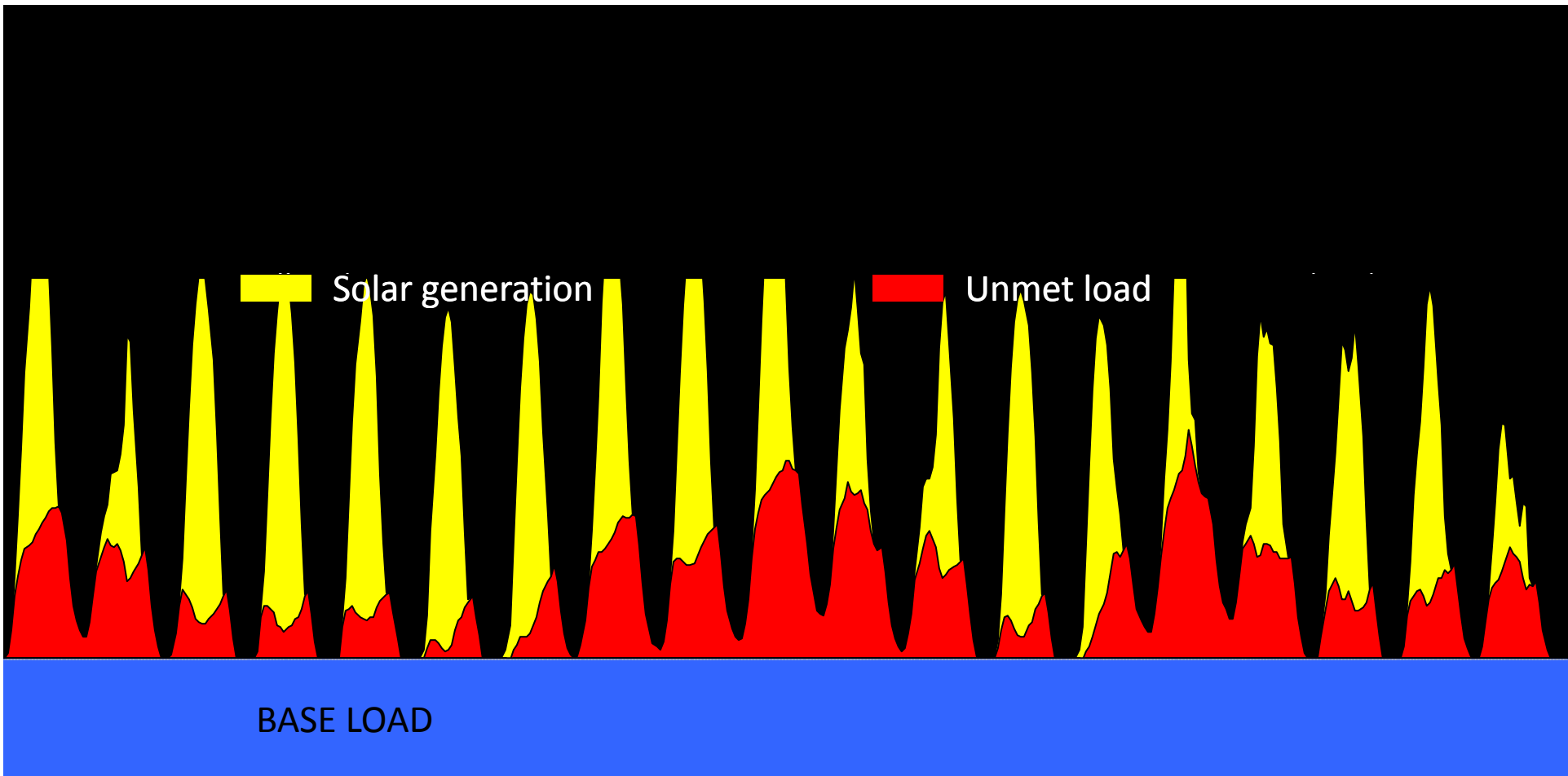


BASE LOAD

Solar generation

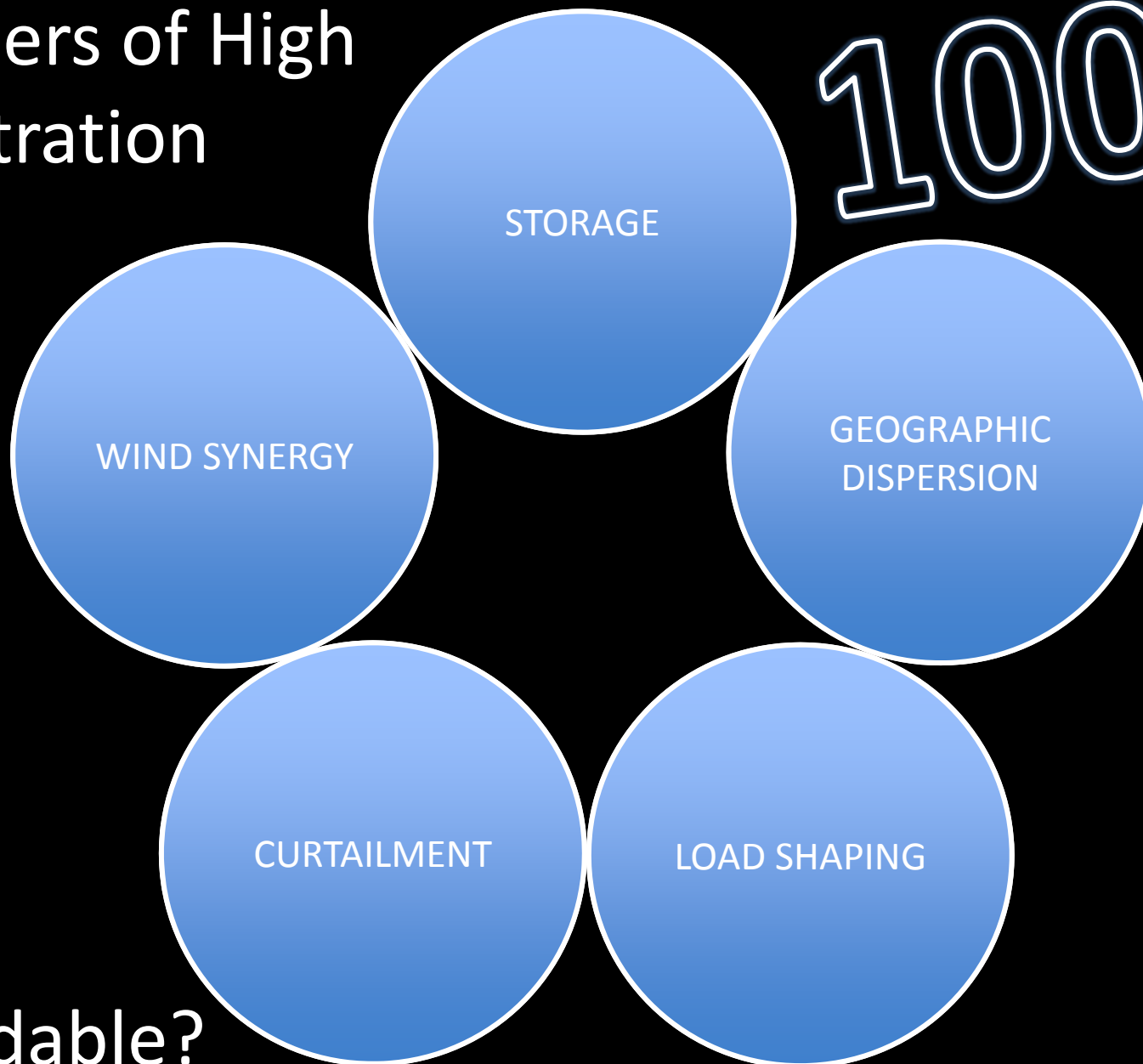
Unmet load





Enablers of High penetration

100%



Affordable?

100%

STORAGE

WIND SYNERGY

GEOGRAPHIC
DISPERSION

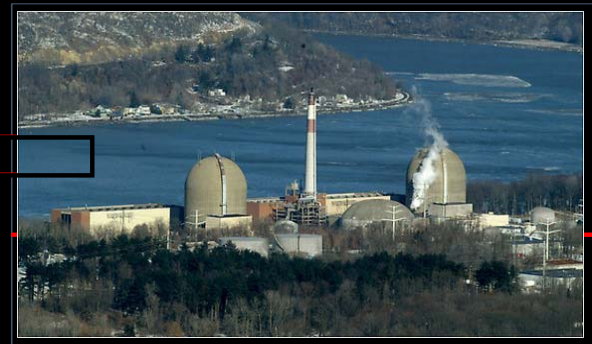
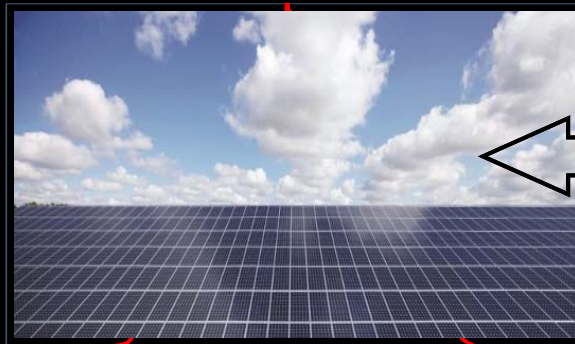
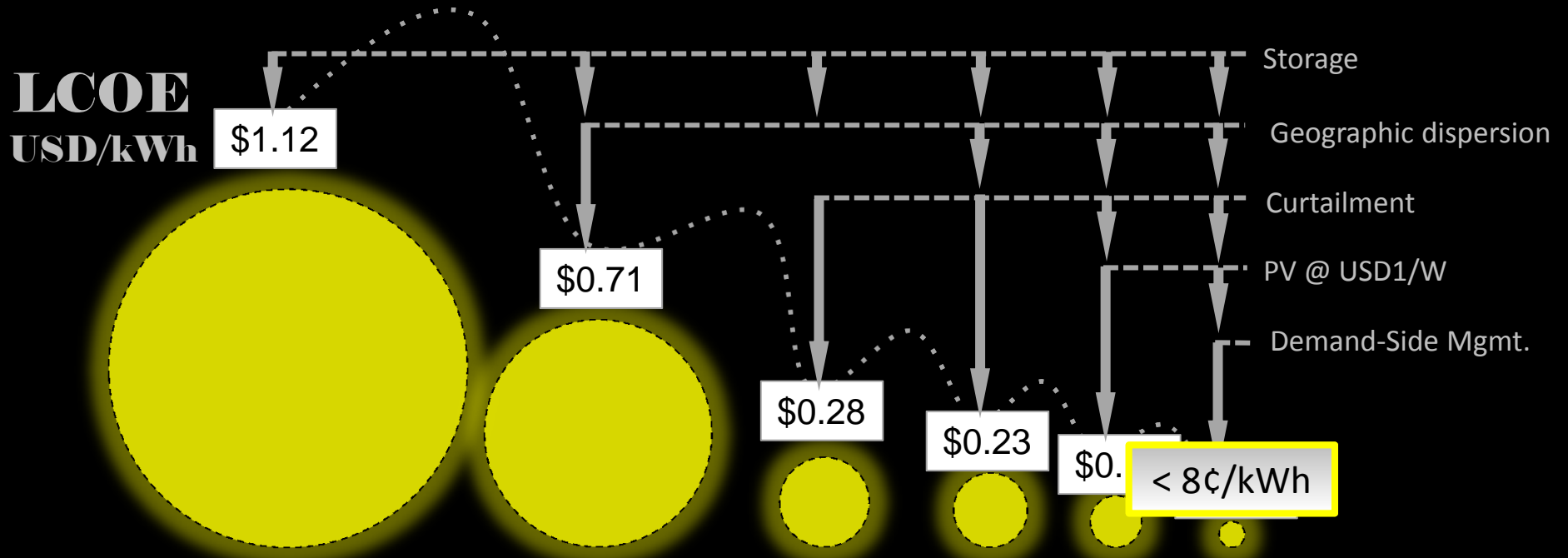
CURTAILMENT

LOAD SHAPING

Affordable?

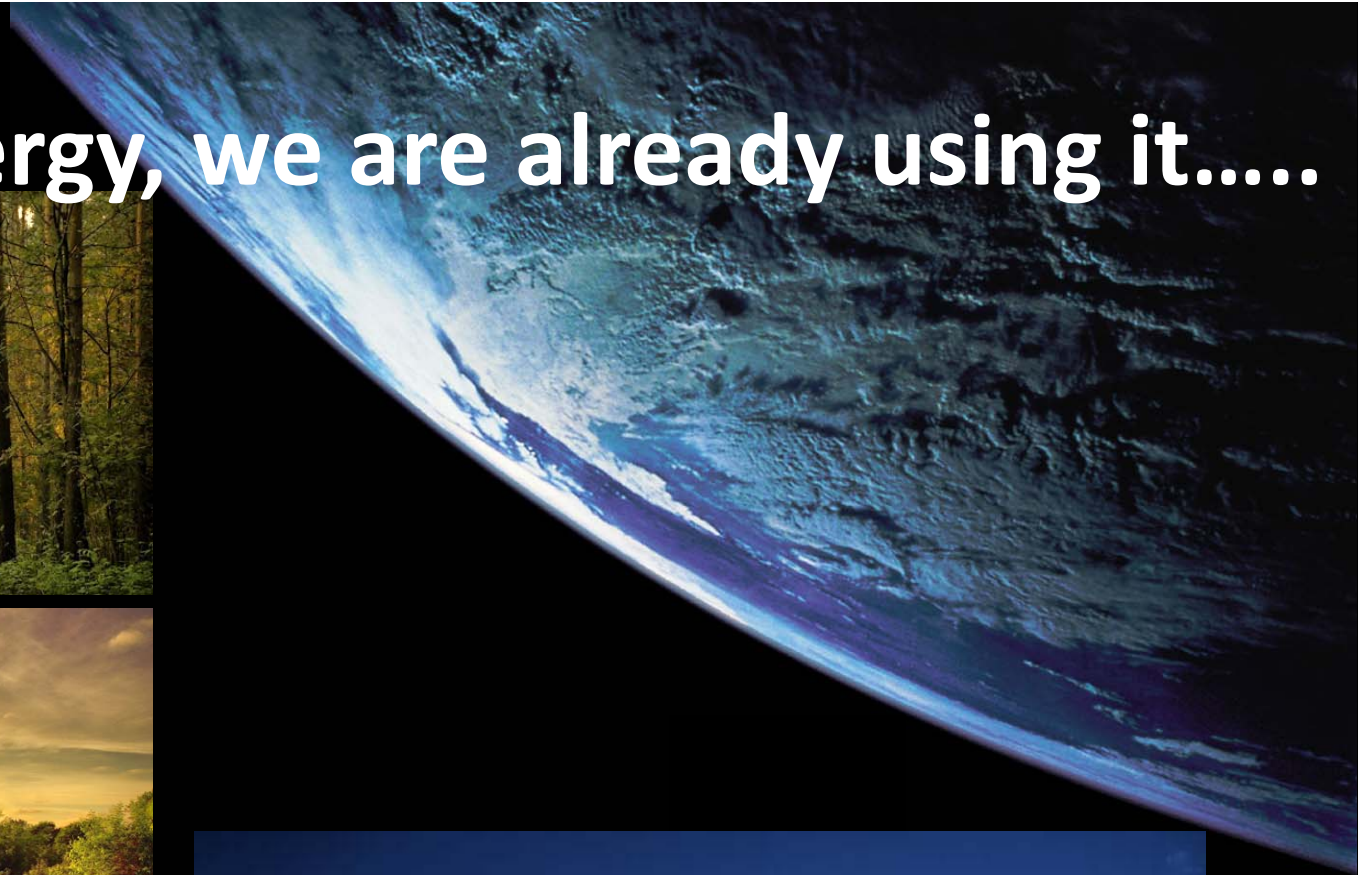
COST OF DELIVERING BASELOAD OUTPUT WITH PV IN CENTRAL US

Source M. Perez, U. Columbia & IEA SHCP Task 8



epilogue

Solar Energy, we are already using it.....





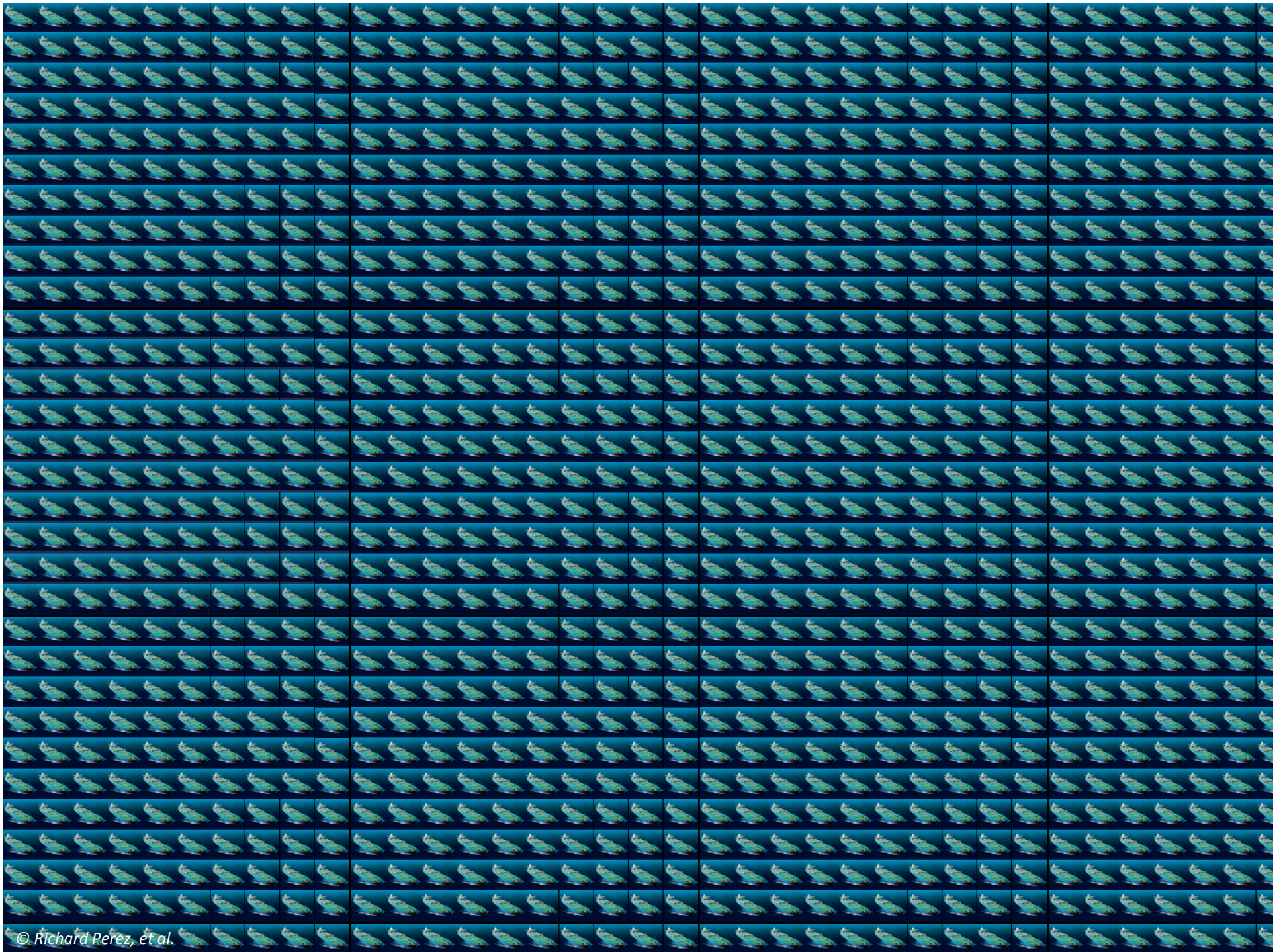
ULTRA LARGE CRUDE CARRIER

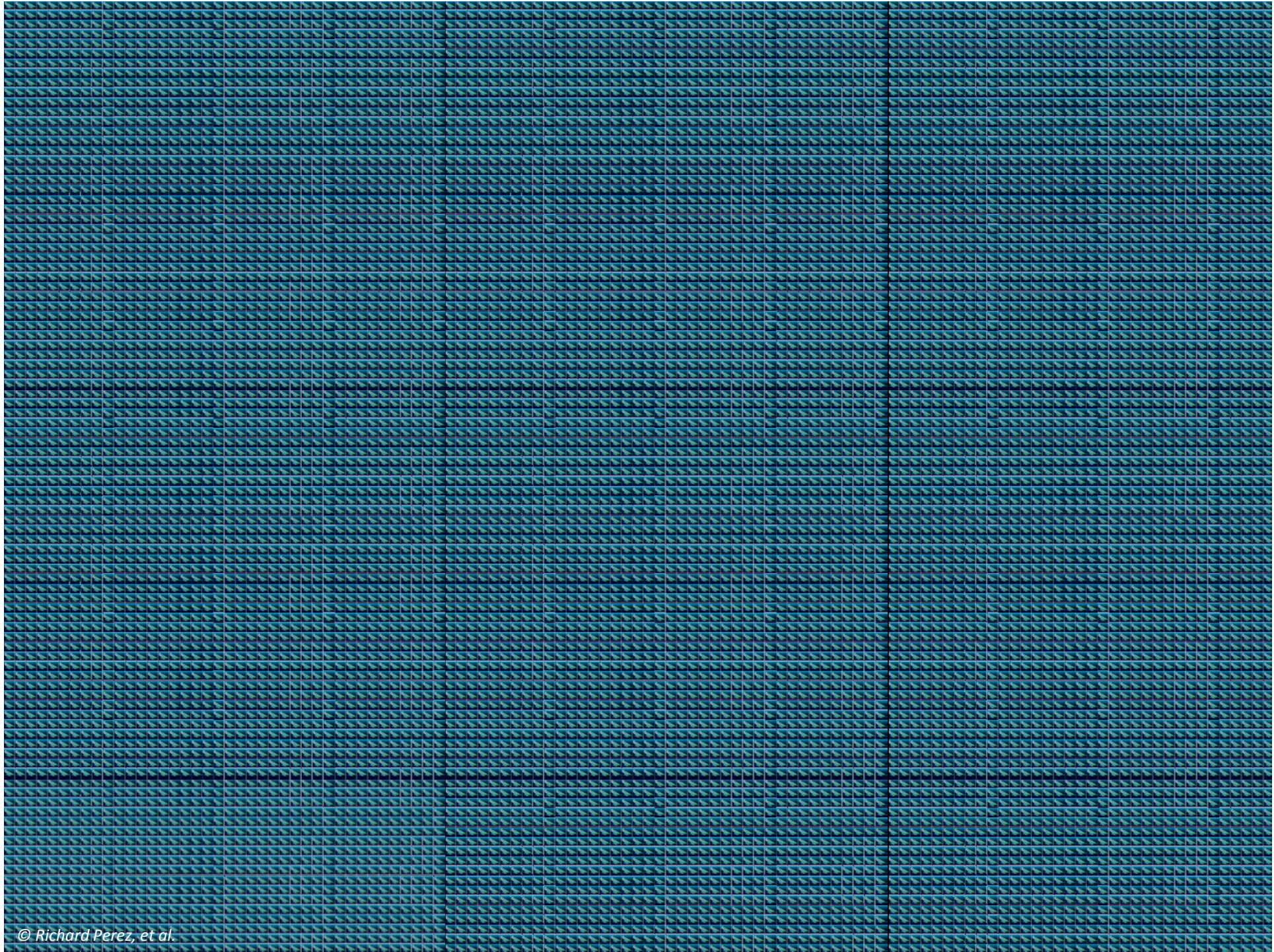
How many would it take ?



PRODUCING DAYLIGHT ARTIFICIALLY?









ULTRA LARGE CRUDE CARRIER

110,000,000
\$ 50,000 TRILLION per year

TWO DAYS



© AAA.