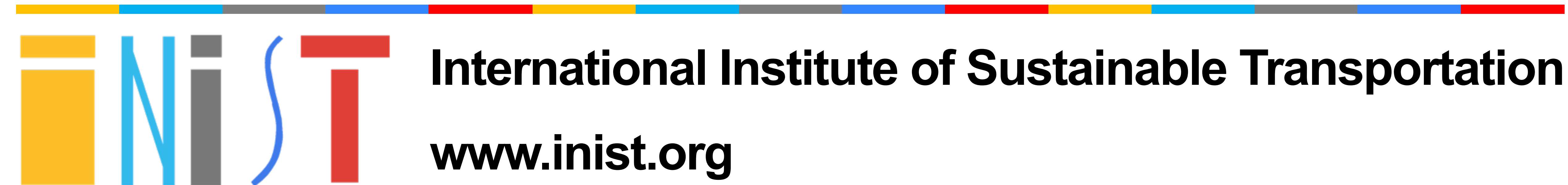


Solar Skyways Network



Bringing makers together from around the world to create solar transportation networks

Energy: The Key to Entitlements for Podcar Networks Ron Swenson November 6, 2015



We are organizing a network of universities to create sane transit networks around the world



We are organizing a network of universities to create sane transit networks around the world

- ***Solar-powered ...***



We are organizing a network of universities to create sane transit networks around the world

- ***Solar-powered ...***
- ***Automated ...***



We are organizing a network of universities to create sane transit networks around the world

- ***Solar-powered ...***
- ***Automated ...***
- ***Nonstop ...***



We are organizing a network of universities to create sane transit networks around the world

- ***Solar-powered ...***
- ***Automated ...***
- ***Nonstop ...***
- ***Elevated ...***



We are organizing a network of universities to create sane transit networks around the world

- ***Solar-powered ...***
- ***Automated ...***
- ***Nonstop ...***
- ***Elevated ...***

for transportation beyond oil



SANE Transportation Networks are unique & robust



SANE Transportation Networks are unique & robust

- Small, driverless vehicles



SANE Transportation Networks are unique & robust

- Small, driverless vehicles
- Exclusive, grade-separated guideway



SANE Transportation Networks are unique & robust

- Small, driverless vehicles
- Exclusive, grade-separated guideway
- Off-line stations: non-stop from origin to destination



SANE Transportation Networks are unique & robust

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- On-demand (taxis)



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- Utilize existing rights-of-way (ROWs)

SANE Transportation Networks are unique & robust

- Small, driverless vehicles
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- Utilize existing rights-of-way (ROWs)
- Encourage Transit oriented development (TOD)

SANE Transportation Networks are unique & robust

- Small, driverless vehicles
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- On-demand (taxis)



- Utilize existing rights-of-way (ROWs)
- Encourage Transit oriented development (TOD)
- Safe

SANE Transportation Networks are unique & robust

- Small, driverless vehicles
- Exclusive, grade-separated guideway
- Off-line stations: non-stop from origin to destination
- On-demand (taxis)



- Utilize existing rights-of-way (ROWs)
- Encourage Transit oriented development (TOD)
- Safe
- ***Solar powered***

Let's consider our origins

FIRE defined humanity ...



“Evidence for the controlled use of fire by Homo erectus beginning some 400,000 years ago has wide scholarly support, with claims regarding earlier evidence finding increasing scientific support.”

But now **FIRE** is raging out of control



But now **FIRE** is raging out of control



**Arctic
Expert
predicts
final
collapse
of sea ice
within four
years**

*guardian.co.uk
Monday 17
September 2012*

But now **FIRE** is raging out of control

**Arctic
Lake
Methane
Ignited by
Katey
Walter
Anthony**

But now **FIRE** is raging out of control

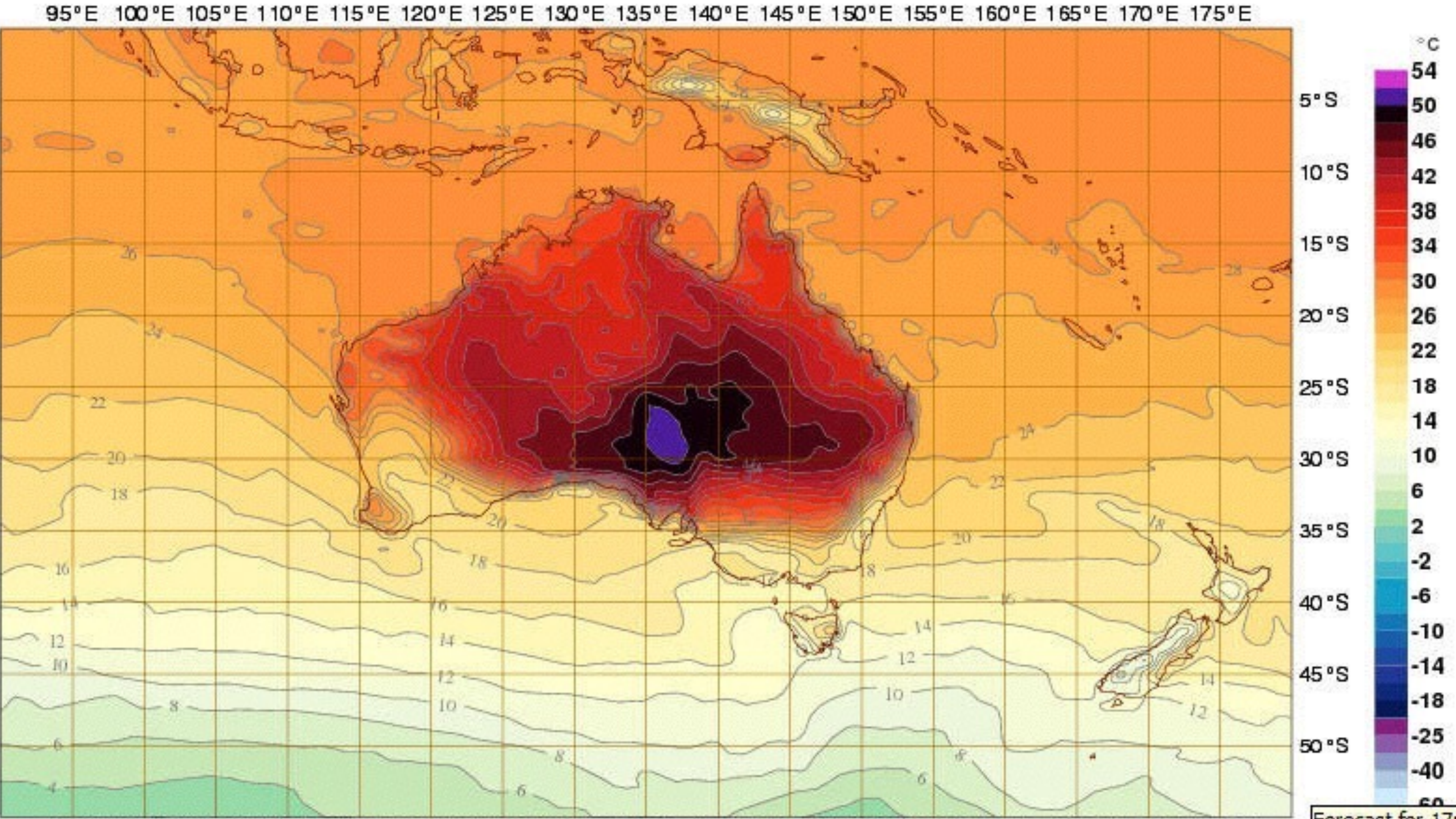


**Arctic
Lake
Methane
Ignited by
Katey
Walter
Anthony**

Australia has a new temperature rating:

Screen Temperature
Valid 06UTC Mon 14 Jan 2013

ACCESS-Global
t+162



© Copyright Commonwealth of Australia 2013, Australian Bureau of Meteorology

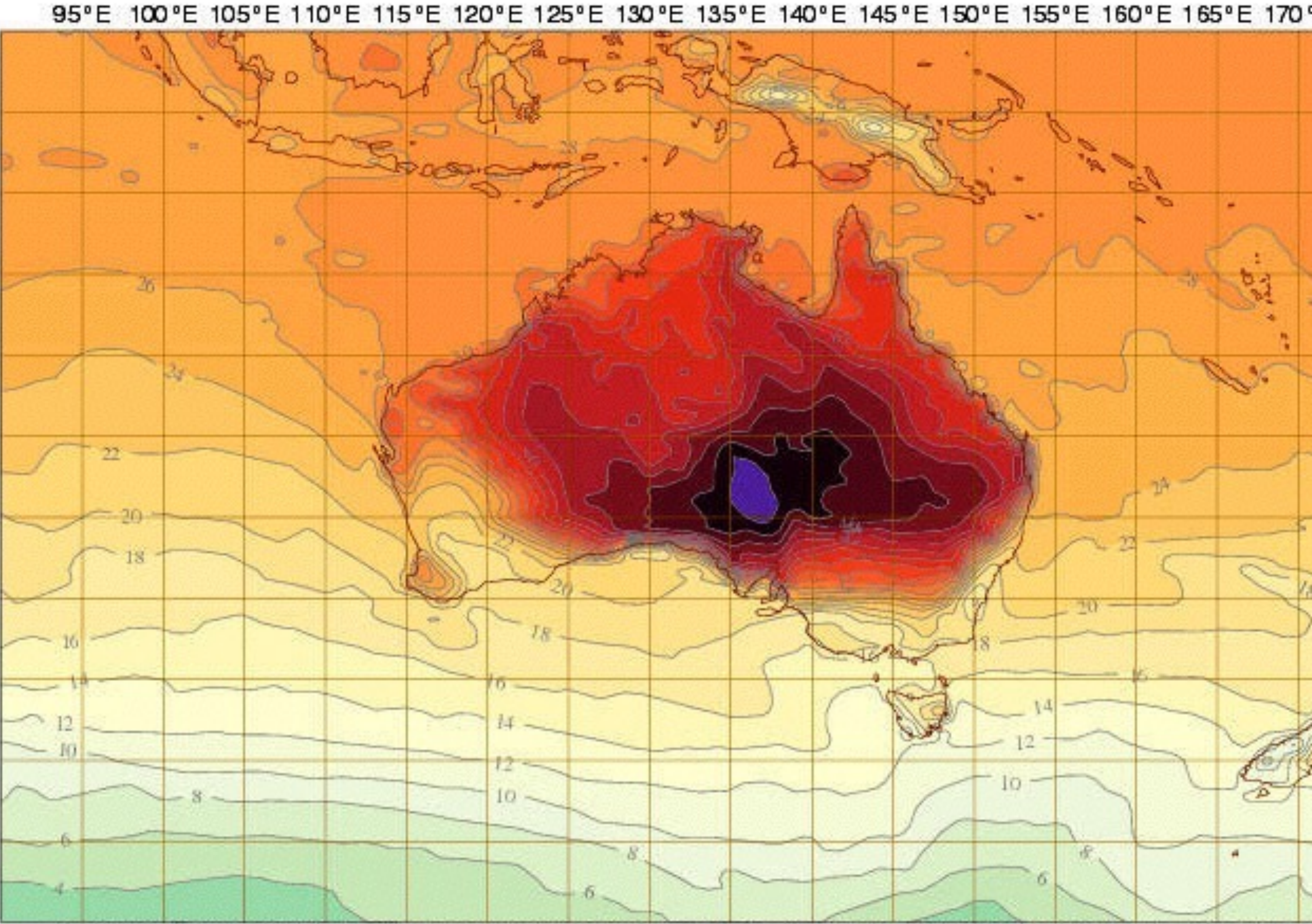
Forecast for 17:00 AEDT on Monday 14 January 2013

Australia has a new temperature rating:



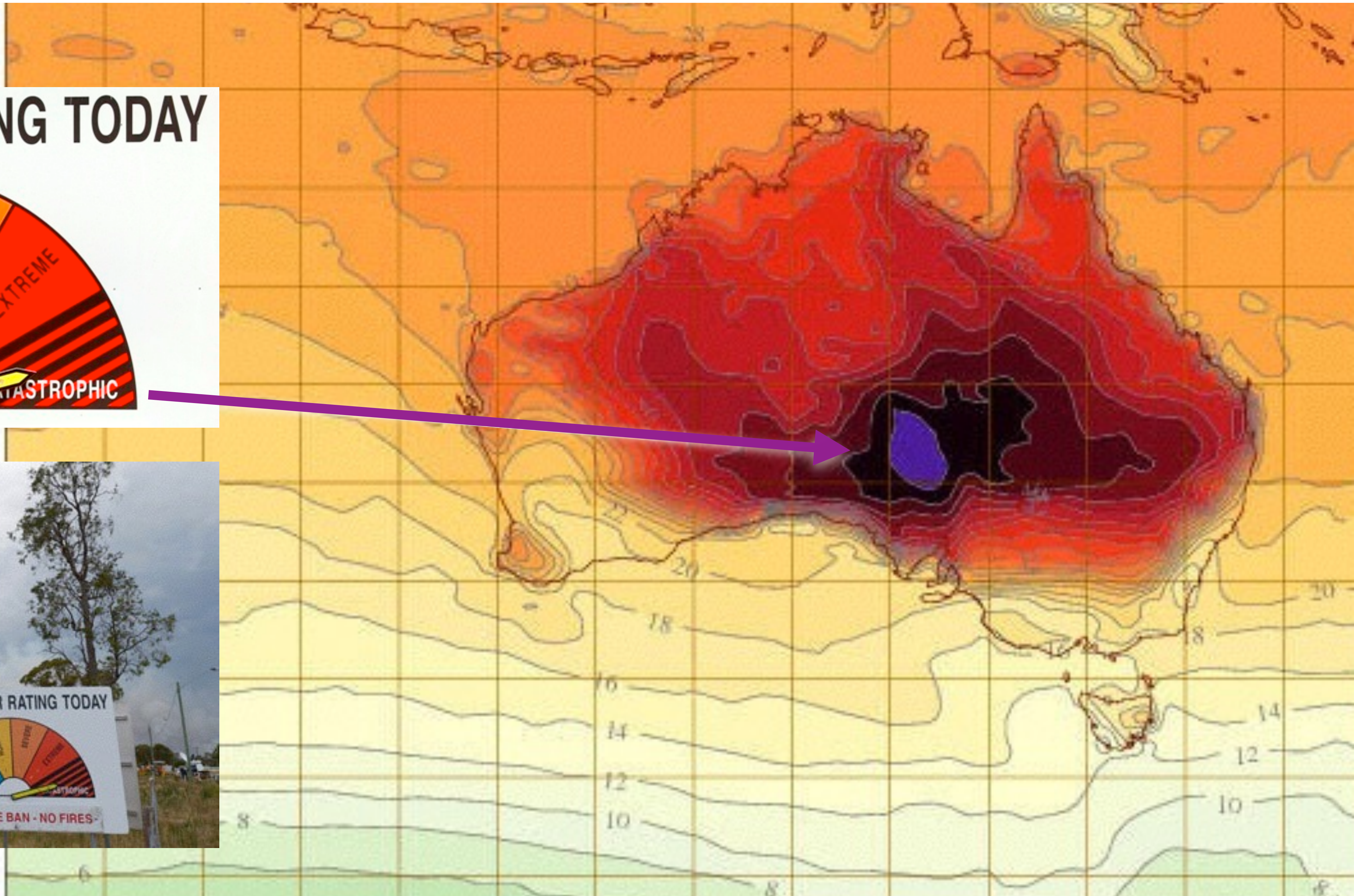
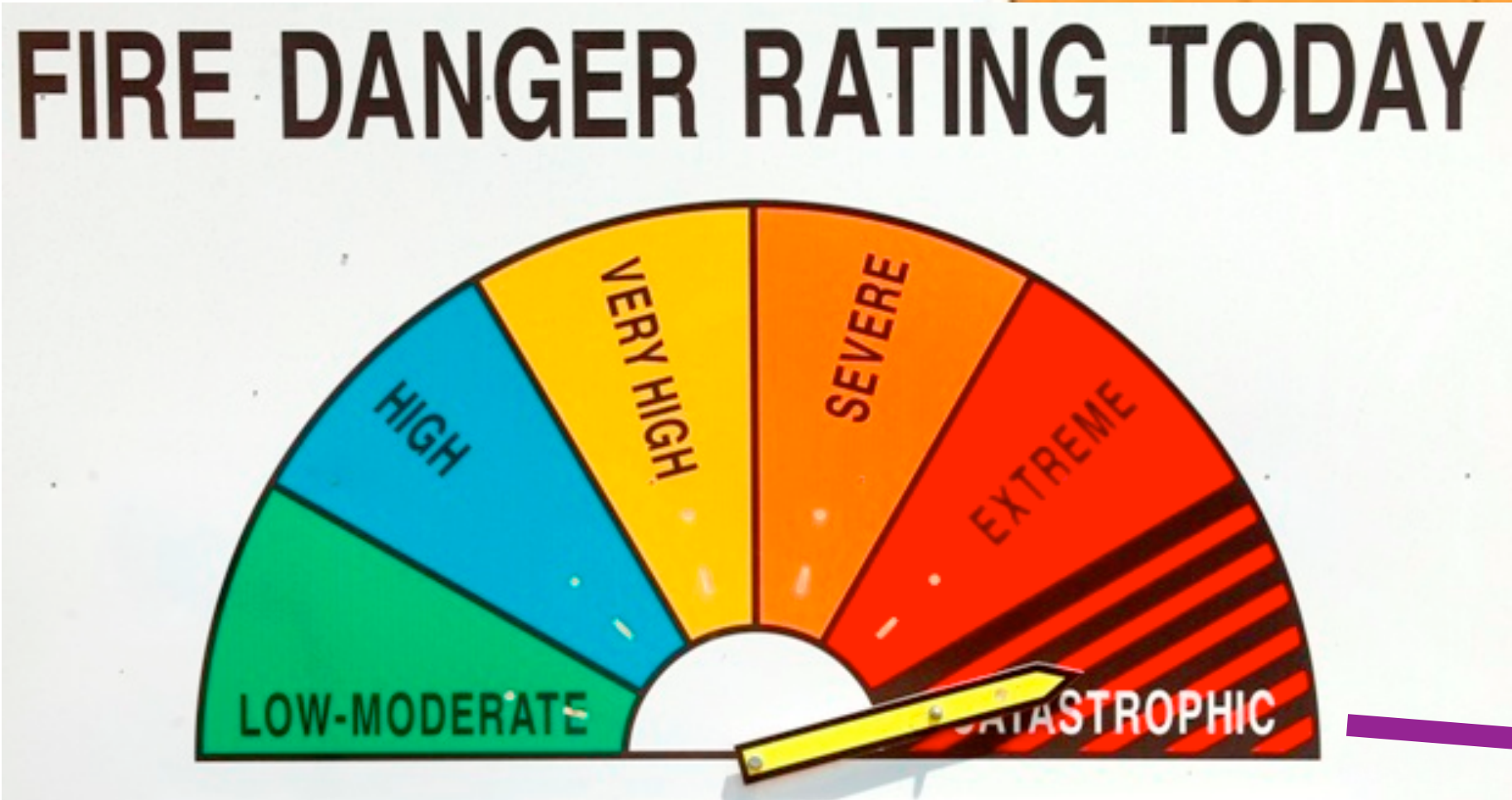
Screen Temperature
Valid 06UTC Mon 14 Jan 2013

ACCE

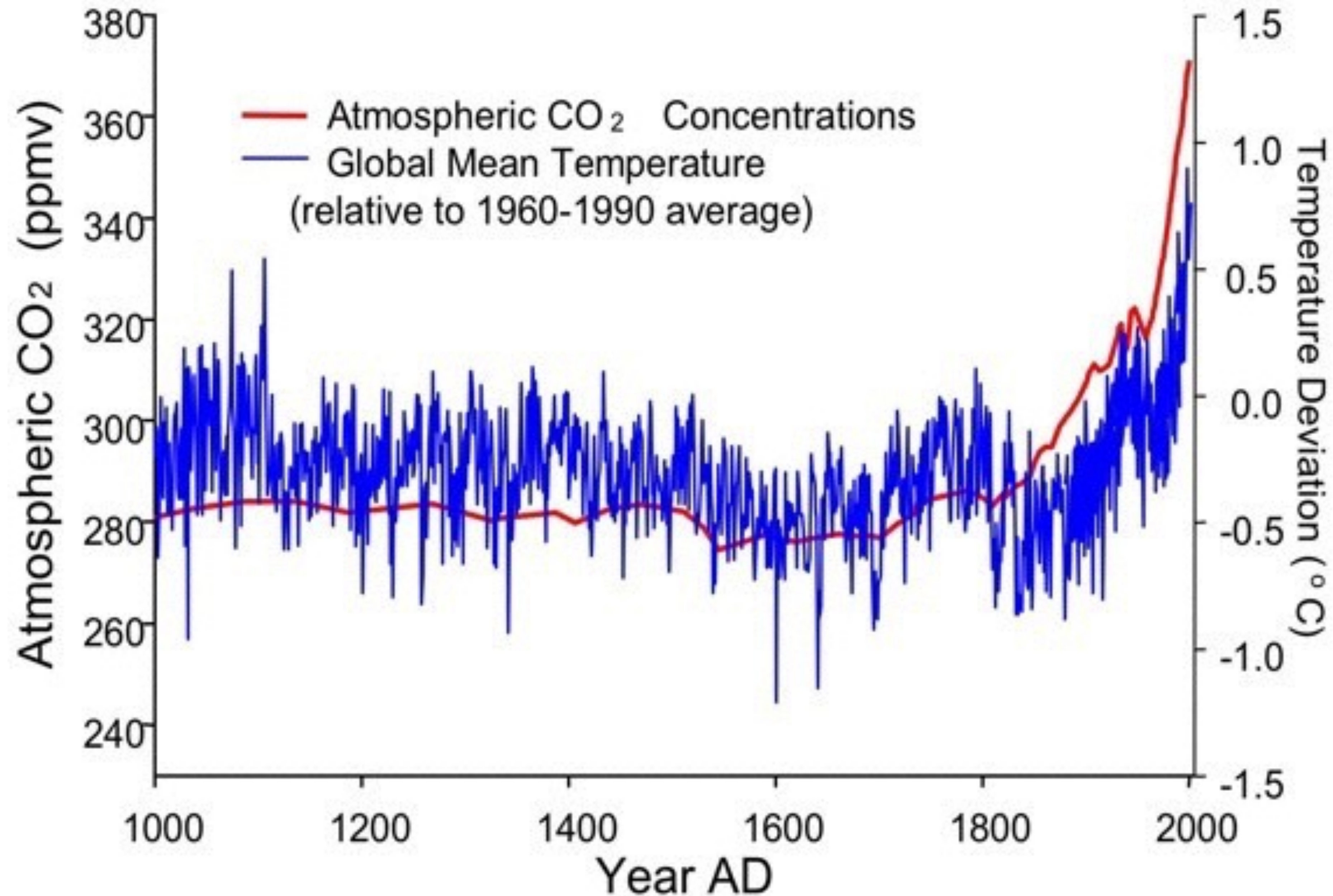


95°E 100°E 105°E 110°E 115°E 120°E 125°E 130°E 135°E 140°E 145°E 150°E 155°E 160°E 165°E 170°E
© Copyright Commonwealth of Australia 2013, Australian Bureau of Meteorology
Forecast for 17:00 AEDT on Monday 14 January 2013

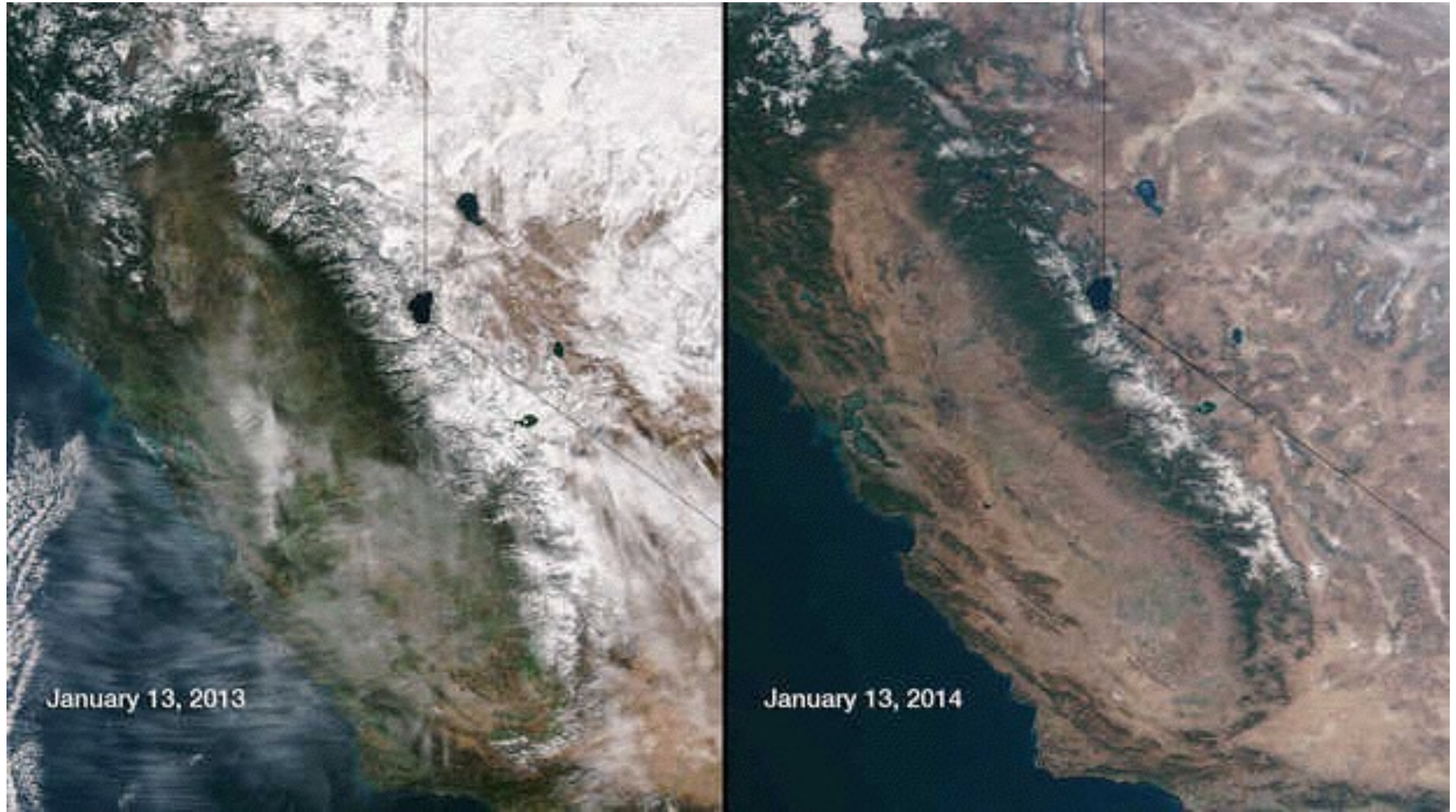
Australia has a new temperature rating: *catastrophic*



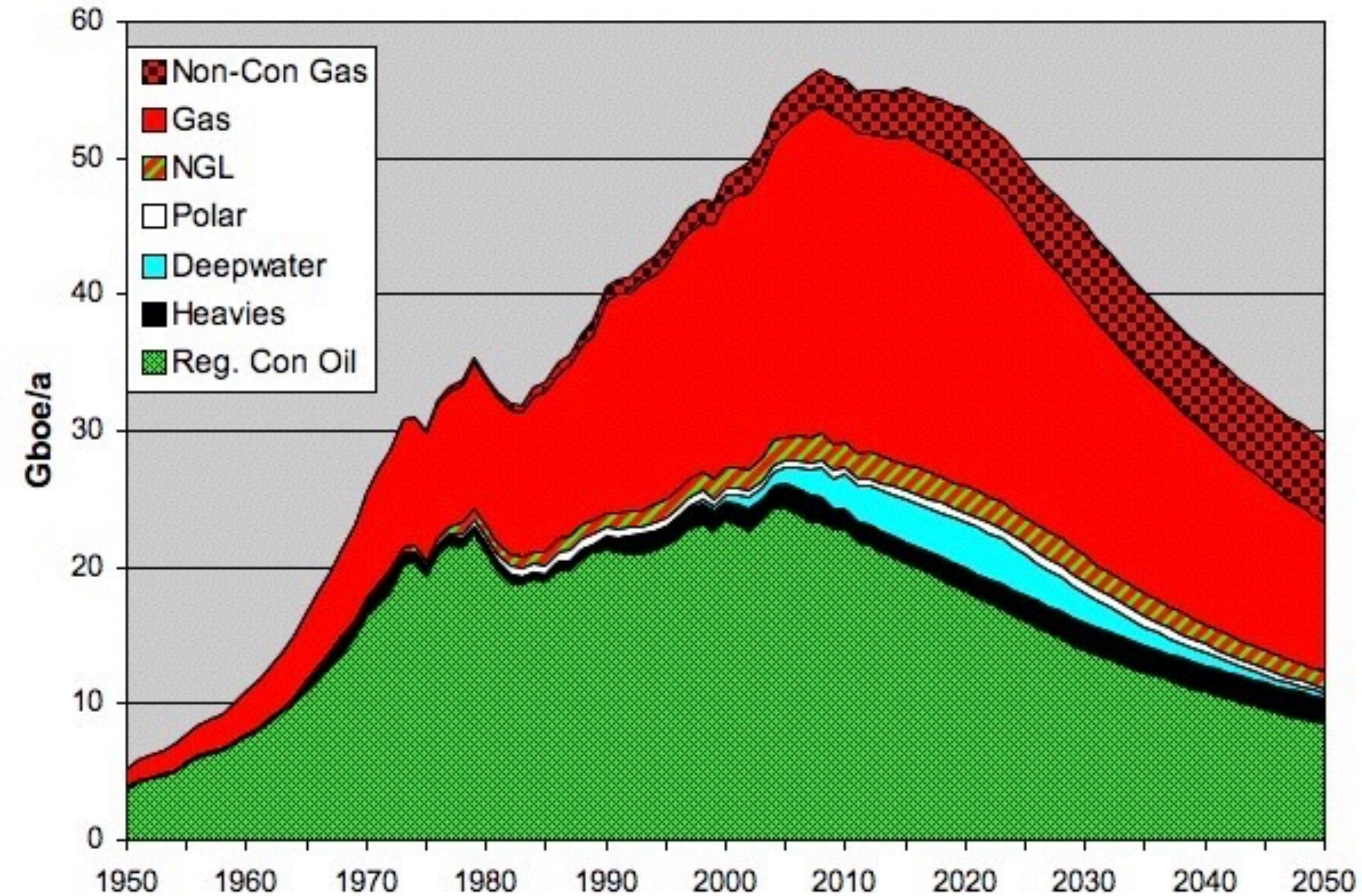
If climate change doesn't get us...



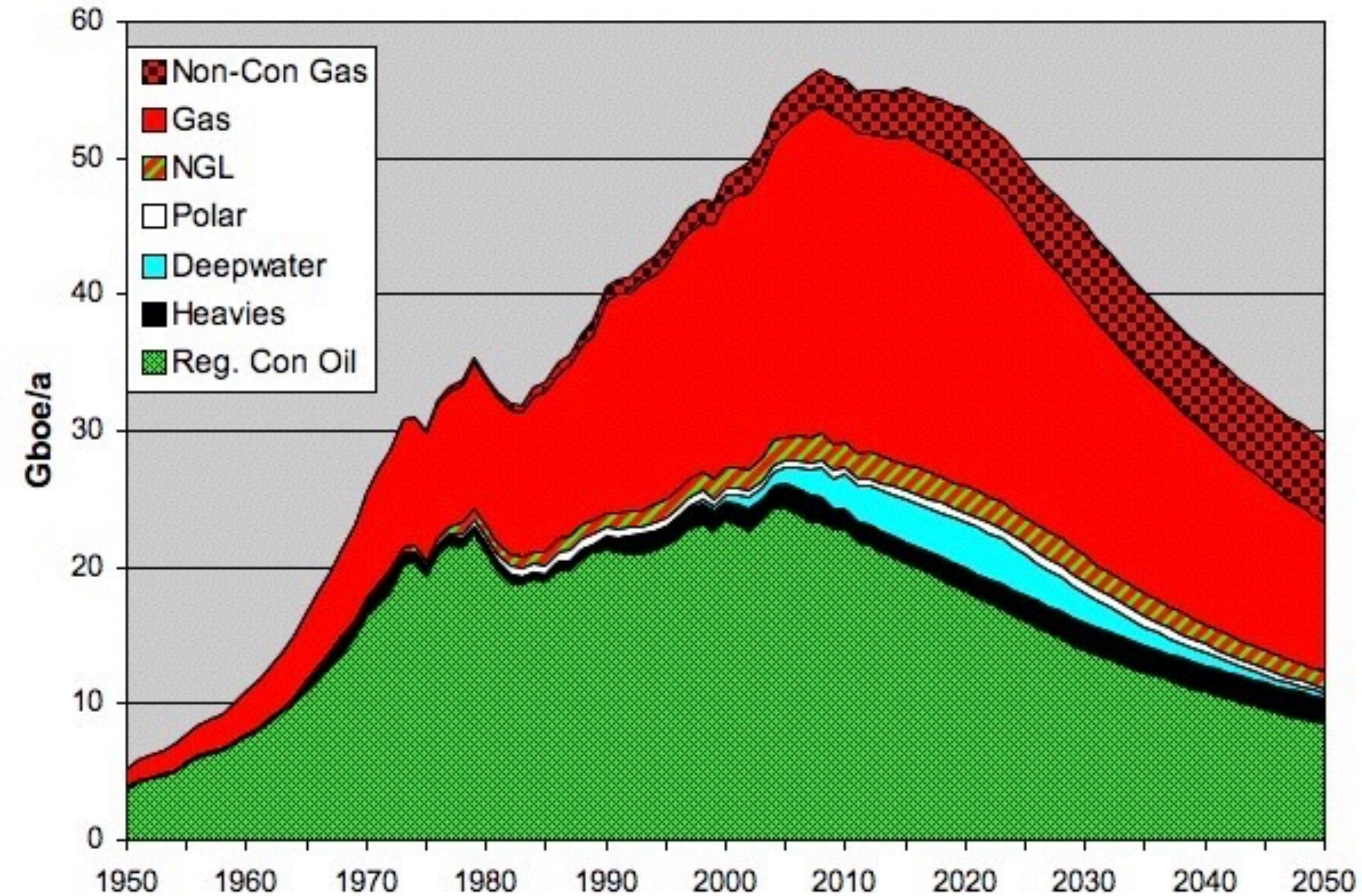
If climate change doesn't get us...



... Peak oil will



... Peak oil will



The oil glut is
a Wall Street
fiction

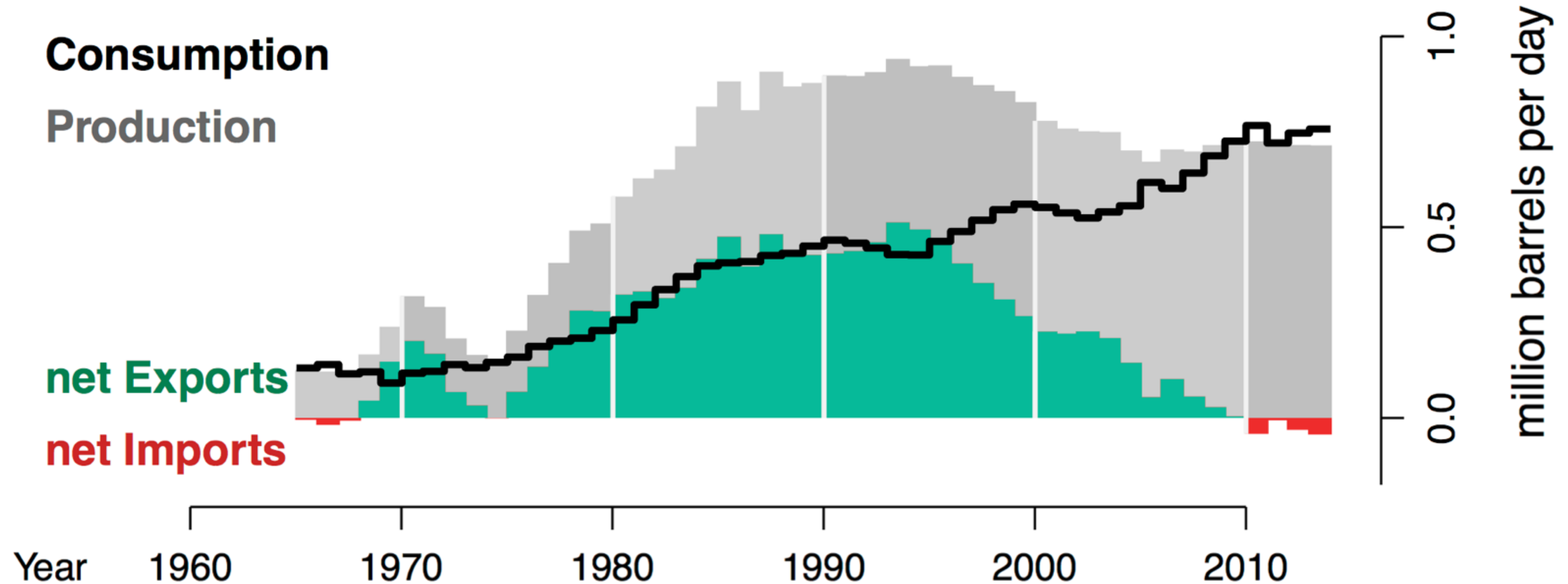
**Knowing this, where
would *you* build podcars?**

**The export land model reveals a very different turn
of events**

The export land model reveals a very different turn of events

Egypt : Oil

2013 imports increased by 39. %

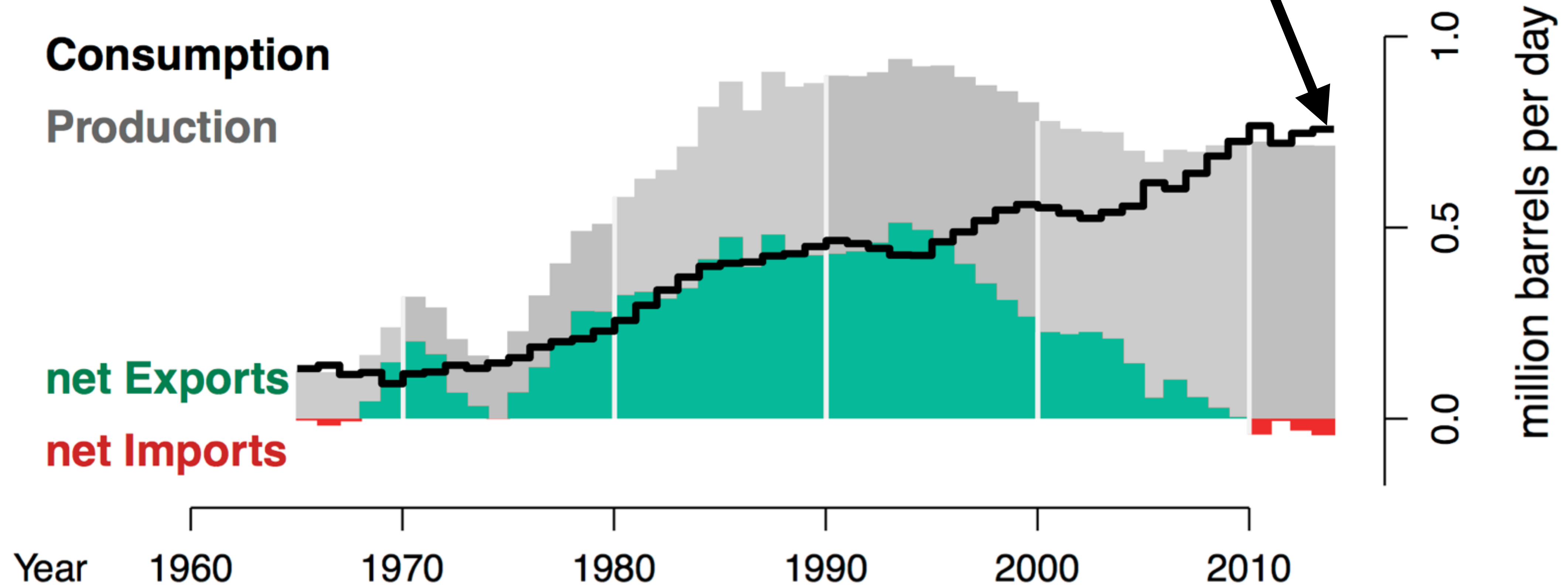


The export land model reveals a very different turn of events

Egypt : Oil

2013 imports increased by 39. %

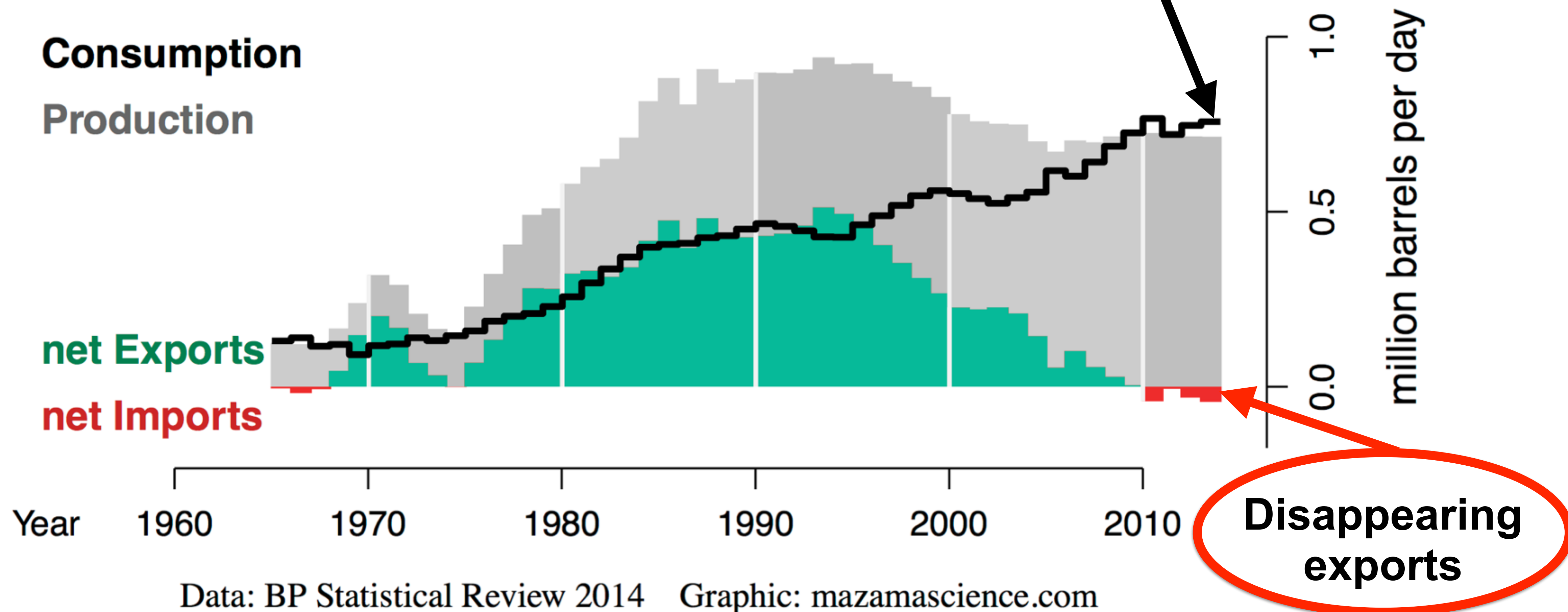
Rising
consumption



The export land model reveals a very different turn of events

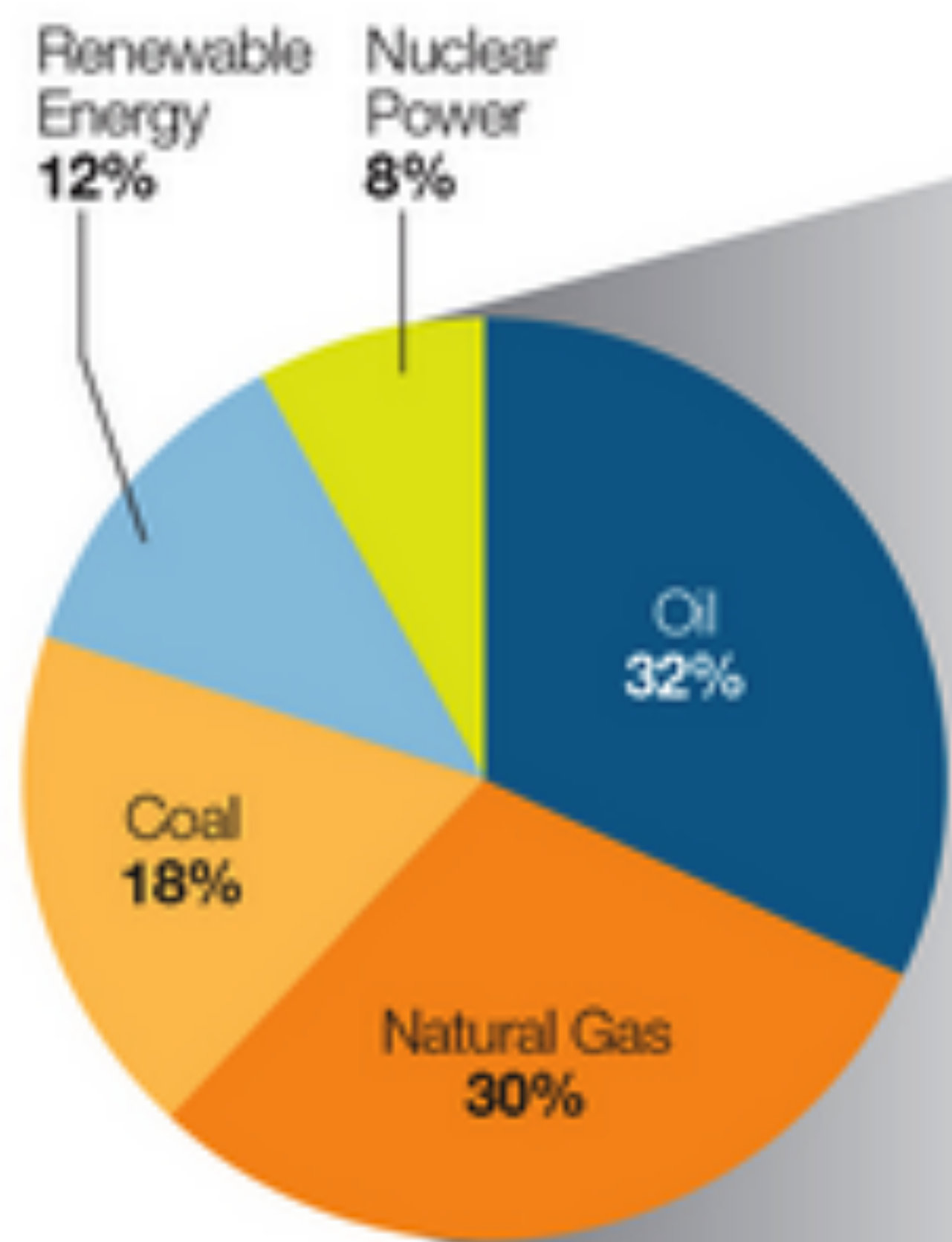
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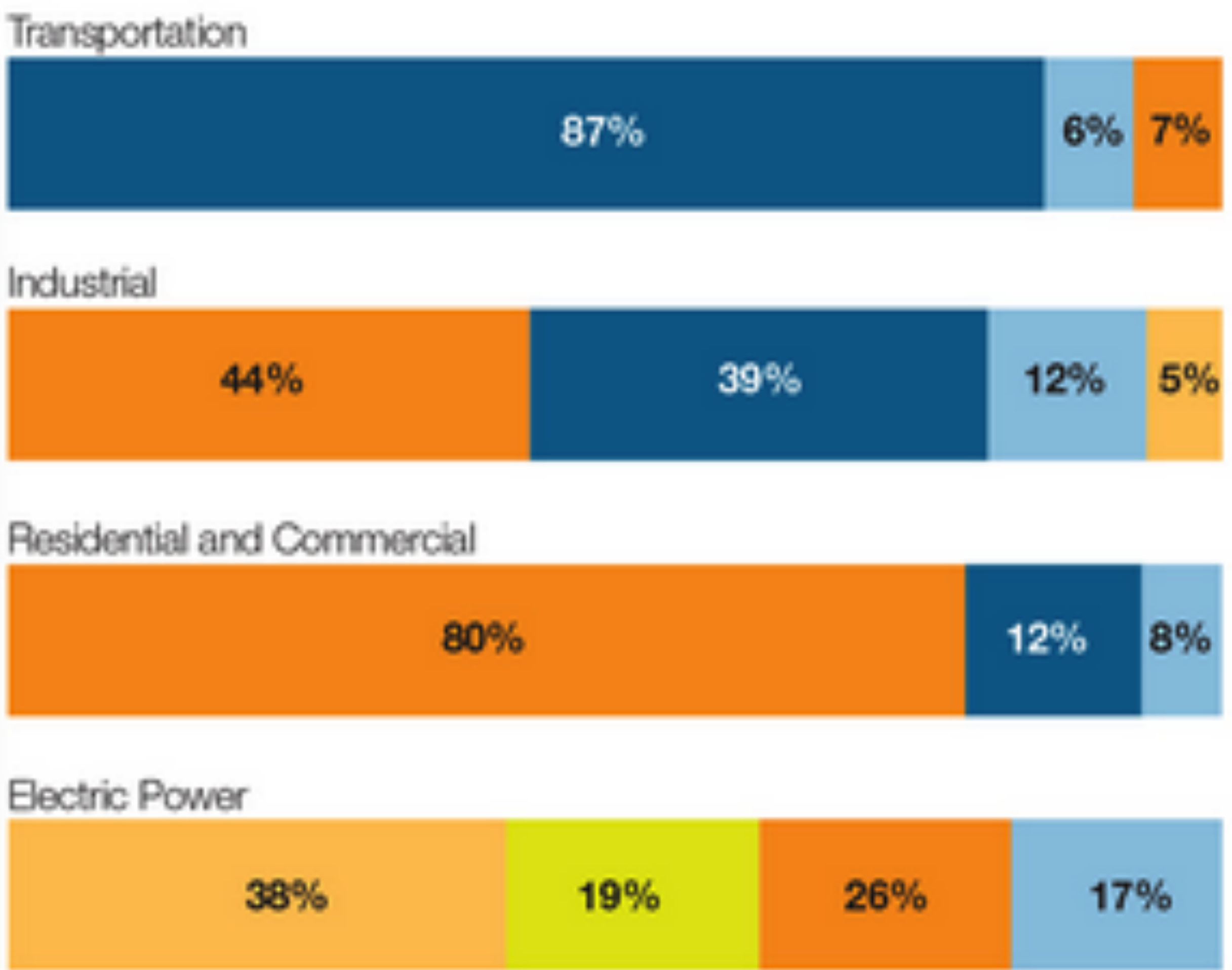


Oil dominates transportation energy in the USA

Total Energy Consumption by Fuel



Sector Energy Consumption by Fuel Type



Source: AEO 2014, Early Release, Tables A1, A2 and A17.

Oil Natural Gas Coal Renewable Energy Nuclear Power

But after oil is extracted, process losses are huge

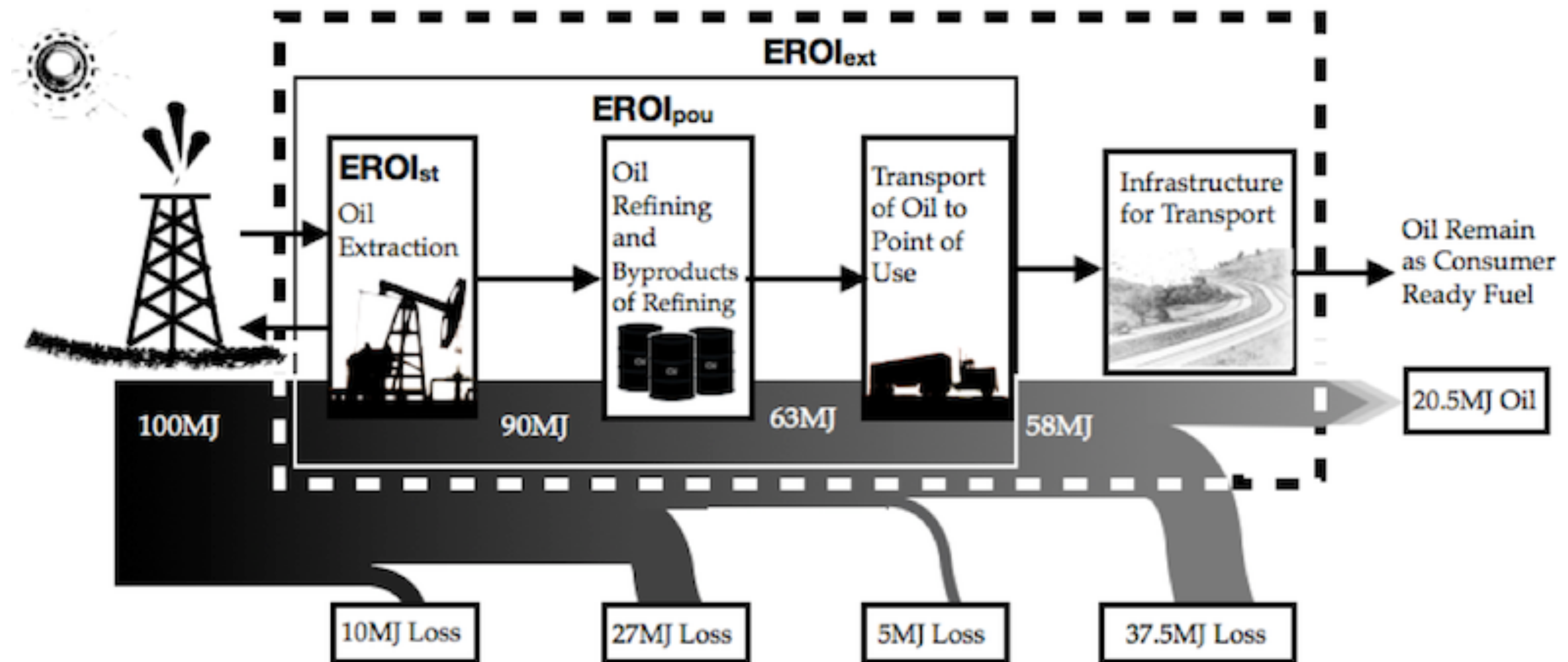
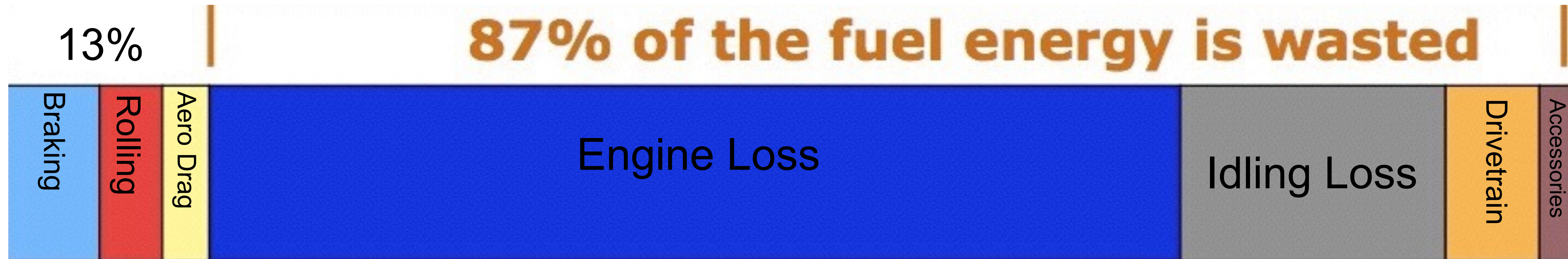


Figure 3: Boundaries of various types of EROI analyses (standard EROI (EROI_{st}), EROI at the point of use (EROI_{pou}) and extended EROI (EROI_{ext})) and energy loss associated with the processing of oil as it is transformed from “oil at the well-head” to consumer ready fuels (figure adapted from Lambert and Lambert, in preparation [3]).

At the end of the daisy chain, liquid fuels don't cut it

Fuel-based engines are incredibly inefficient



100kg people & 1,000 kg metal: most of the useful energy is used to move metal...

Less than 1% of the total energy moves people!

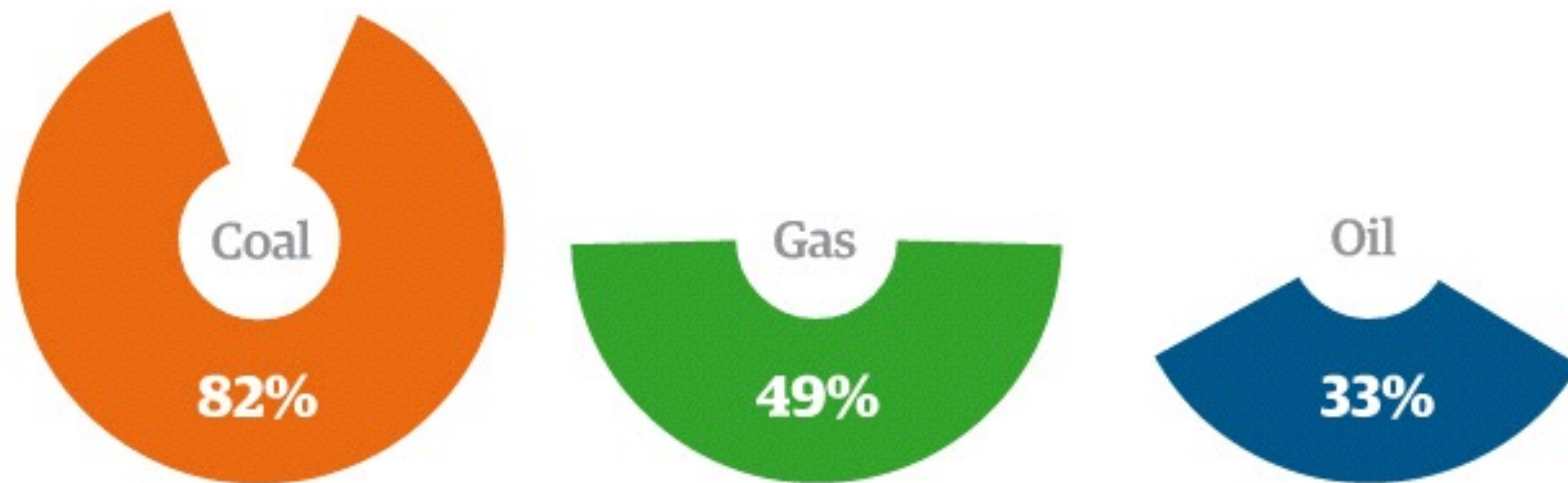
Even if there were plenty of oil, gas and coal, we would have to leave most of it in the ground

Unburnable fossil fuels

Known, extractable coal, oil and gas reserves that must not be burnt in order to prevent dangerous climate change of more than 2C

Global reserves

Per cent that cannot be burned



The future is in our hands



The future is in our hands





So June 15, 1752 is a date to remember



THE
HISTORY
AND
PRESENT STATE
OF
ELECTRICITY,

WITH
ORIGINAL EXPERIMENTS,

By JOSEPH PRIESTLEY, LL.D. F.R.S.

THE THIRD EDITION,
CORRECTED AND ENLARGED.

Causa latet, vis est notissima. OVID.

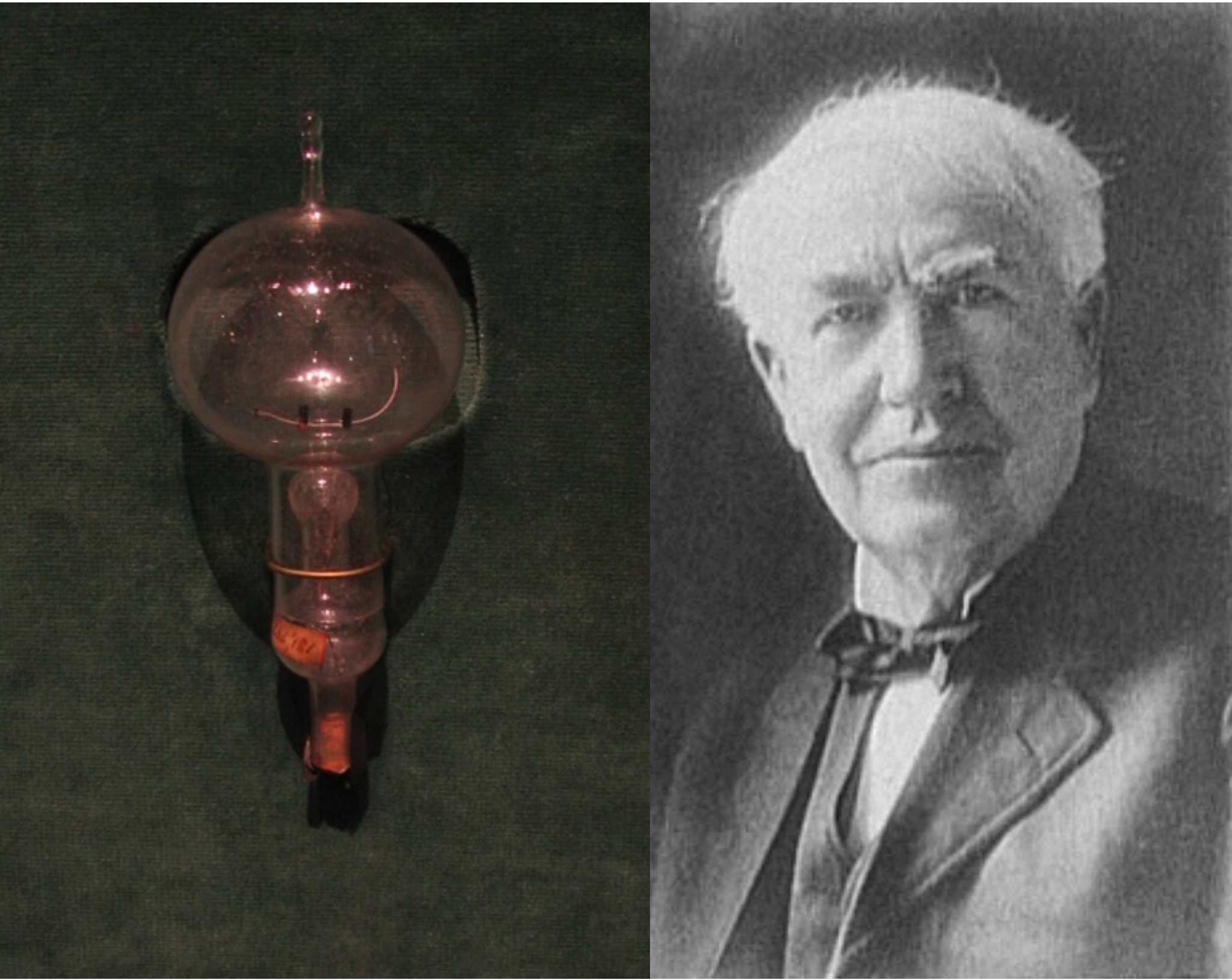
VOL. II.

LONDON,

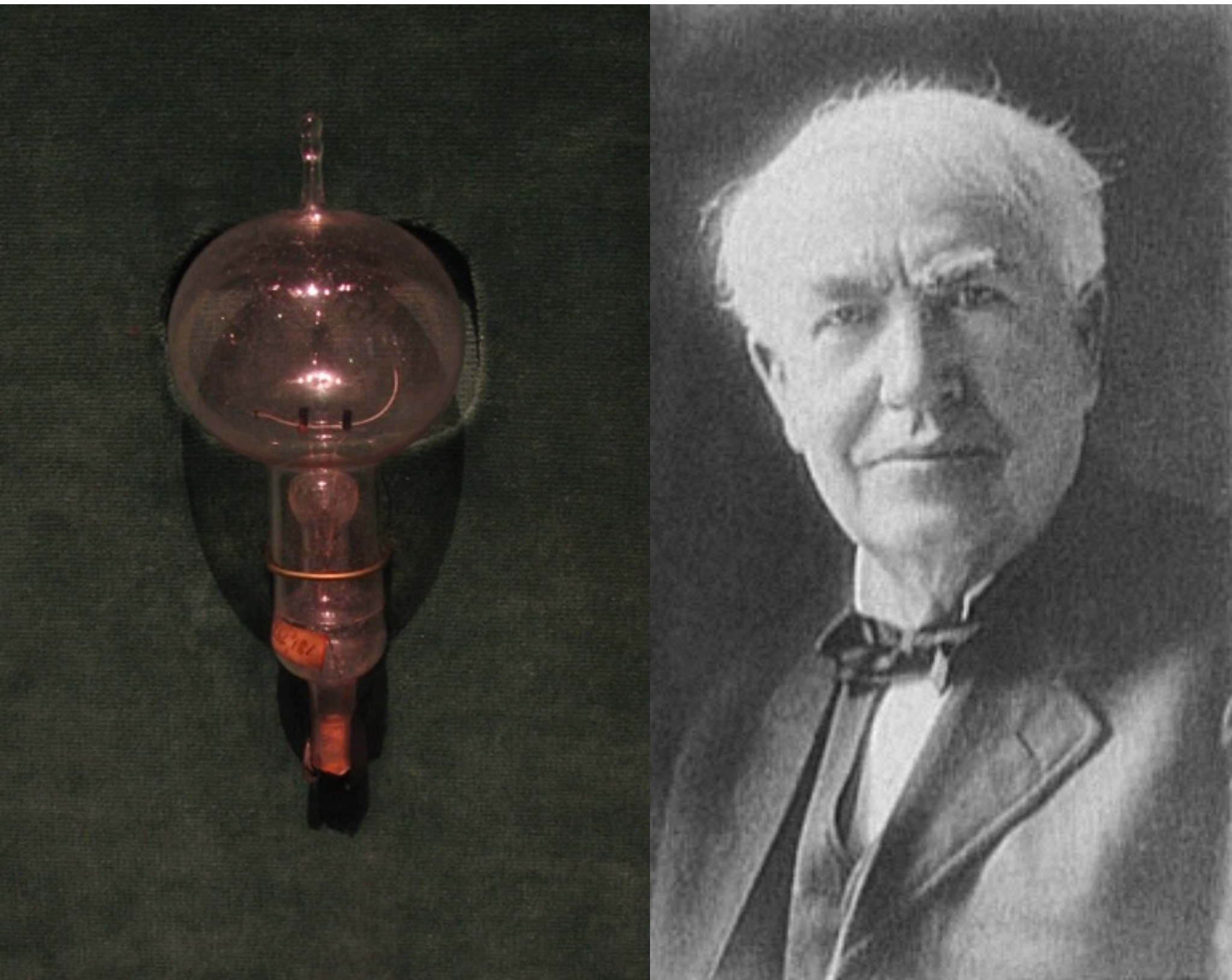
Printed for C. BATHURST, and T. LOWNDES, in Fleet-Street;
J. RIVINGTON, and J. JOHNSON, in St. Paul's Church-Yard;
S. CROWDER, G. ROBINSON, and R. BALDWIN, in Paternoster Row;
T. BECKET, and T. CADELL, in the Strand.

MDCCLXXV.

October 22, 1879 is also a key date to remember



October 22, 1879 is also a key date to remember

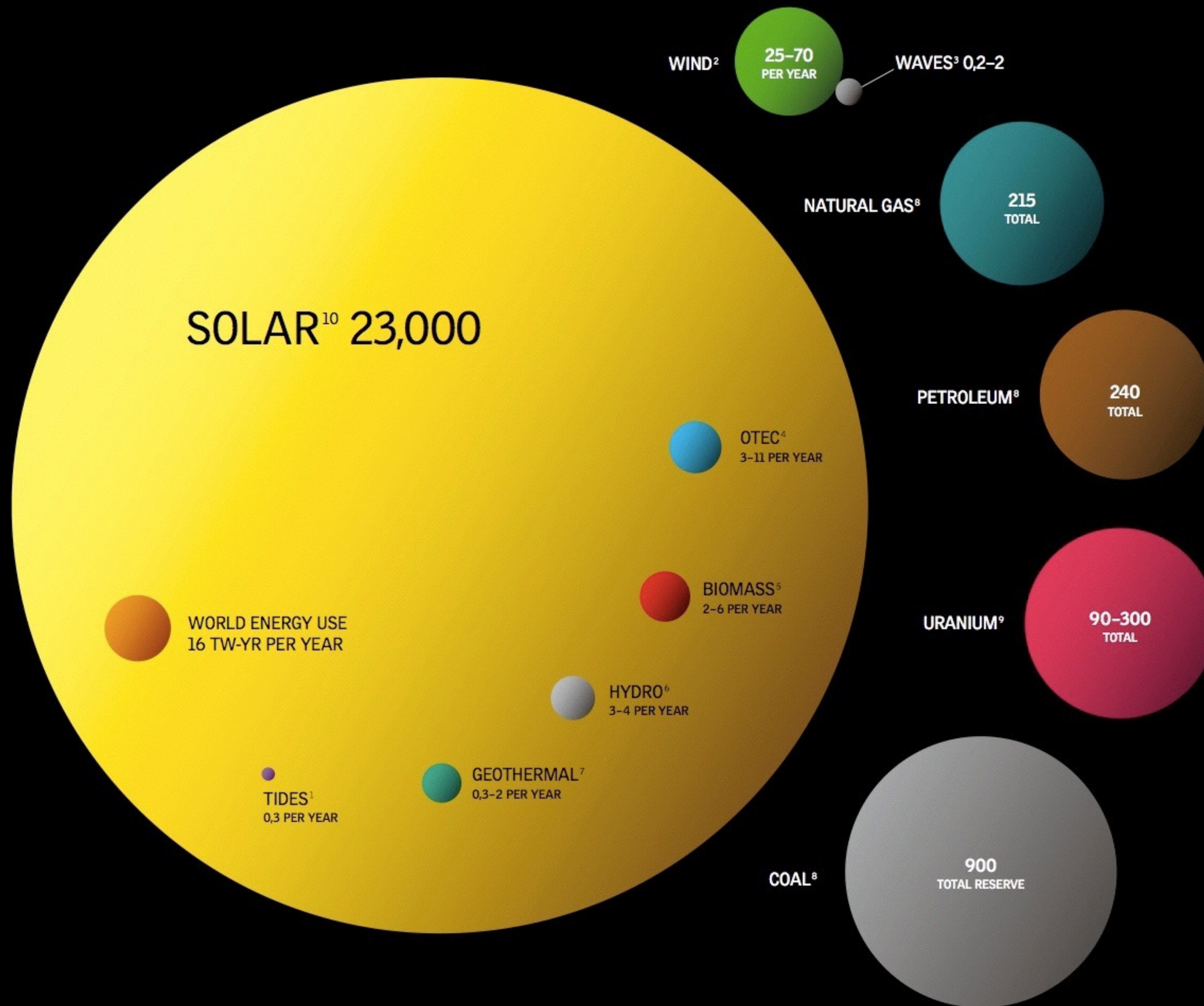


What Edison said in 1910 is the rest of the story

"Sunshine is spread out thin and so is electricity. Perhaps they are the same, Sunshine is a form of energy, and the winds and the tides are manifestations of energy."

"Do we use them? Oh, no! We burn up wood and coal, as renters burn up the front fence for fuel. We live like squatters, not as if we owned the property."

"There must surely come a time when heat and power will be stored in unlimited quantities in every community, all gathered by natural forces. Electricity ought to be as cheap as oxygen...." [1910]



The Global Solar Energy Balance is in our favor

Solar Energy Input (TeraWatts)	178,000
Reflected to Space Immediately	53,000
Absorbed and Then Reflected as Heat	82,000
Used to Evaporate Water (Weather)	40,000
Captured by Plant Photosynthesis	100
Total Energy Used by Human Society	15
Total Energy Used by US Society	2.5
Total Human Food Energy	0.6

**We can't solve problems by using
the same kind of thinking we used
when we created them.**

– Albert Einstein

transportation

We can't solve ^problems by using

fuels

the same kind of ^~~thinking~~ we used

when we created them.

Pete Christensen

– Albert ^Einstein

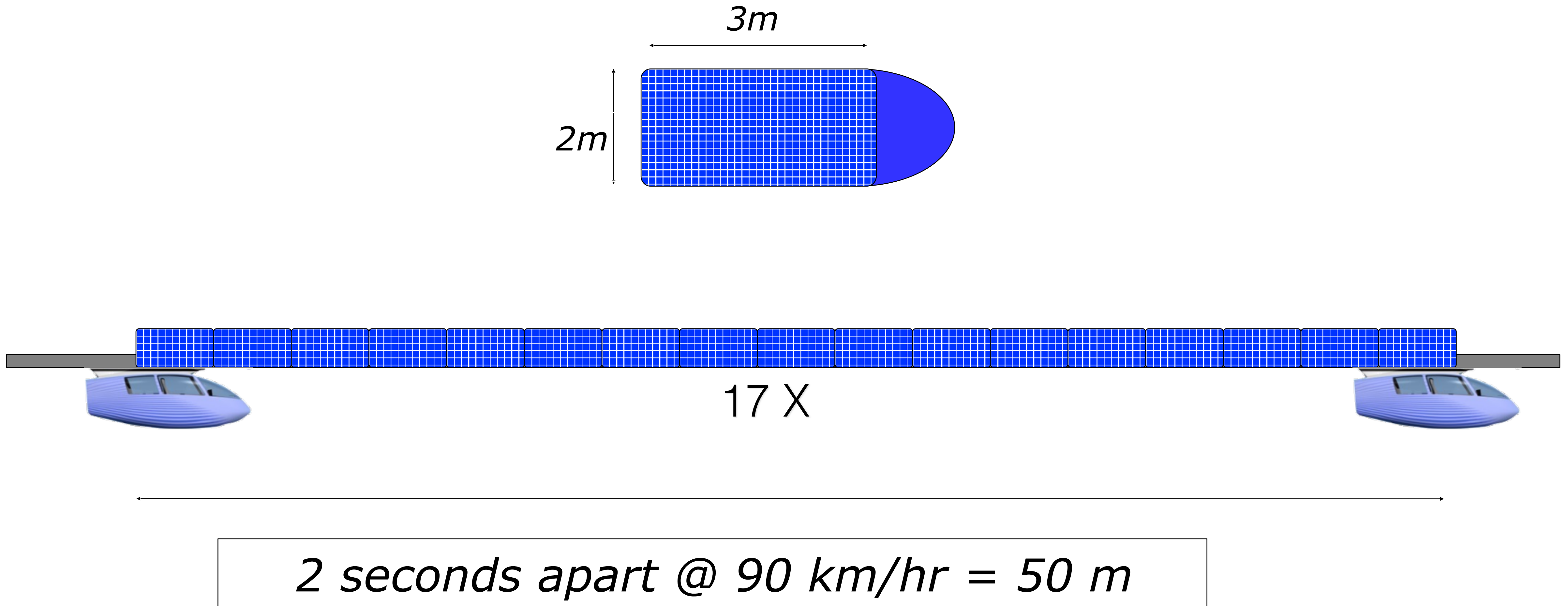
Tonatiuh, el Coche Solar de Carreras, started in 1992



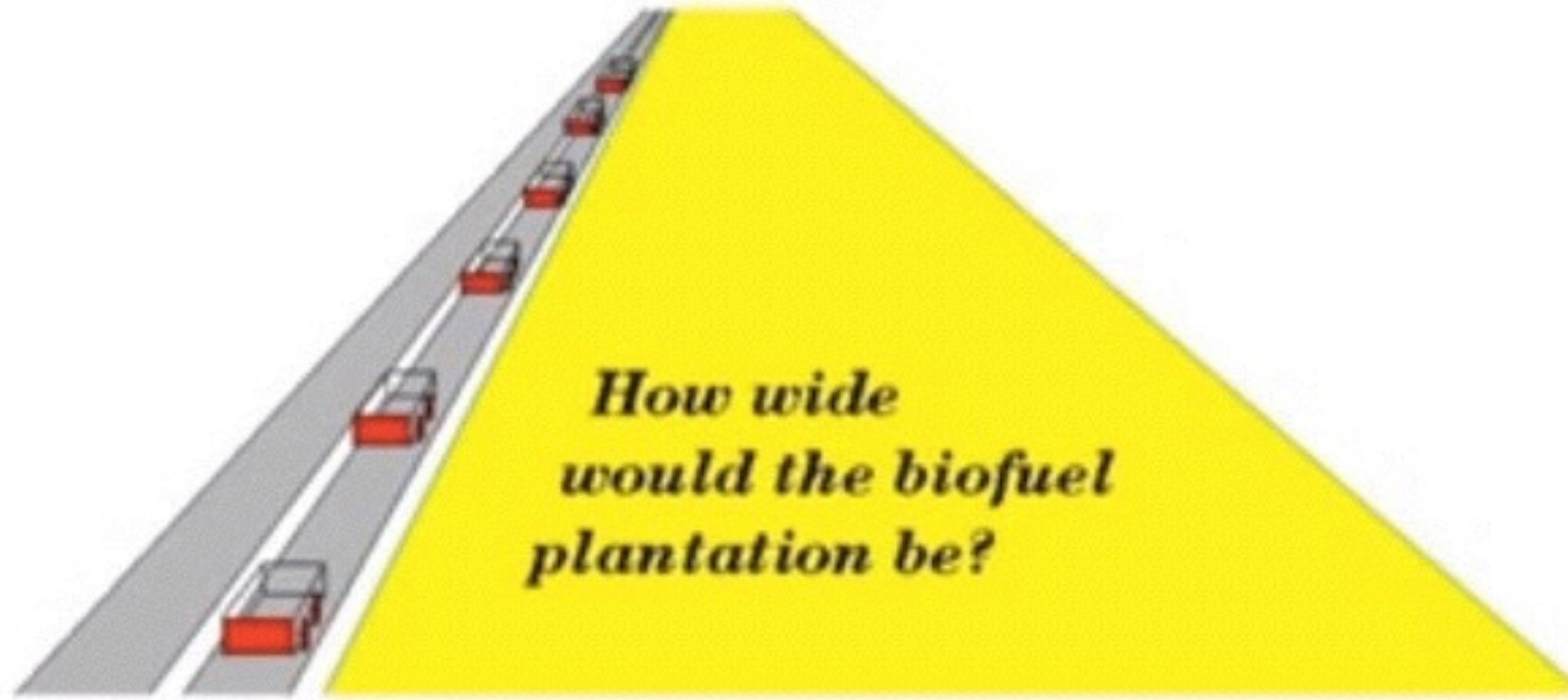
Tonatiuh inspired the Solar Skyways Challenge



The ATN guideway has 17X more solar capacity than solar race cars



One lane of bio-cars



One lane of cars

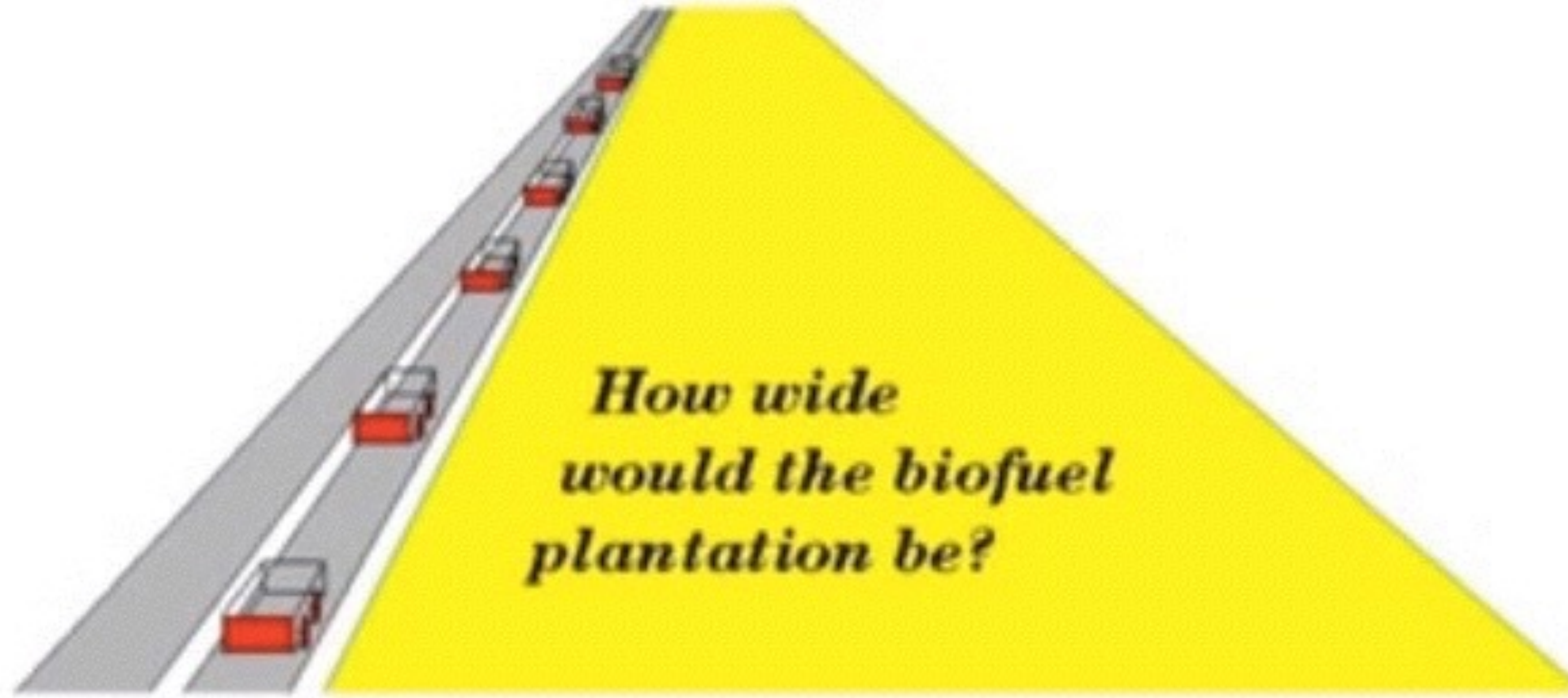
60 miles per hour

30 miles per gallon

1200 litres of biofuel per hectare per year

80 metres car-spacing

One lane of bio-cars



One lane of cars

60 miles per hour

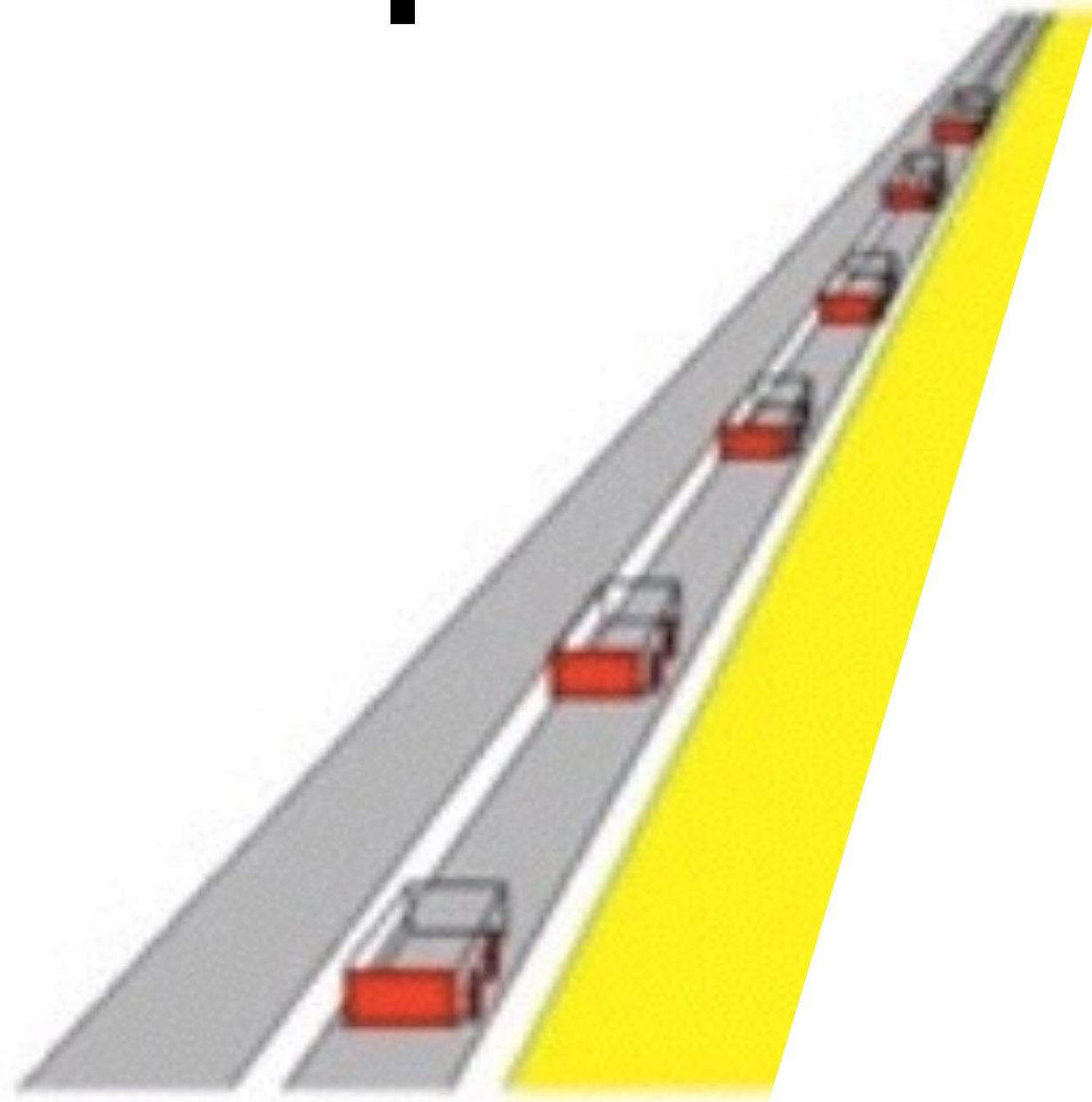
30 miles per gallon

1200 litres of biofuel per hectare per year

80 metres car-spacing

= 8 kilometres wide

One lane of podcars



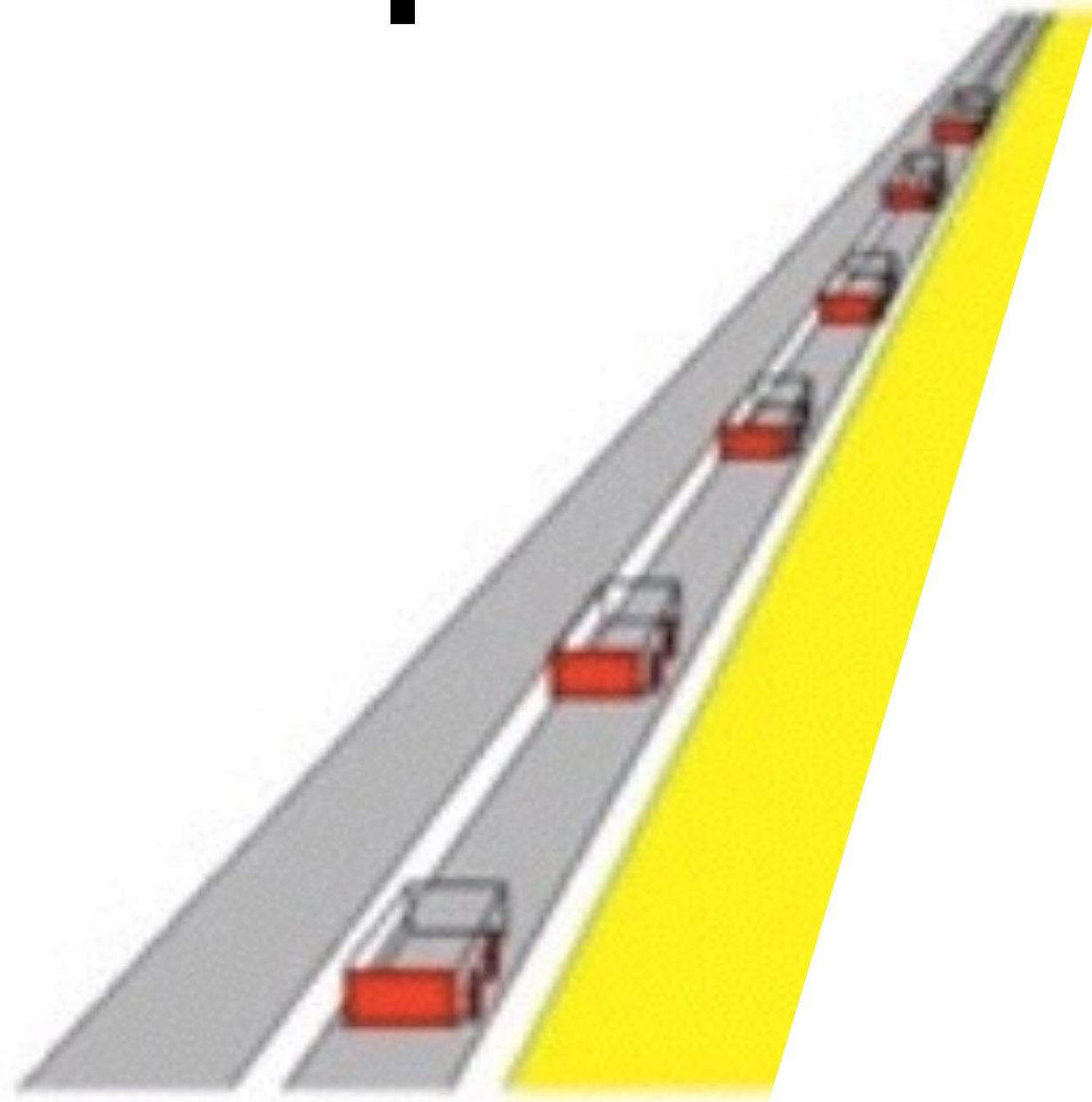
One lane of podcars

60 miles per hour

Solar Powered

80 metres car-spacing

One lane of podcars



One lane of podcars

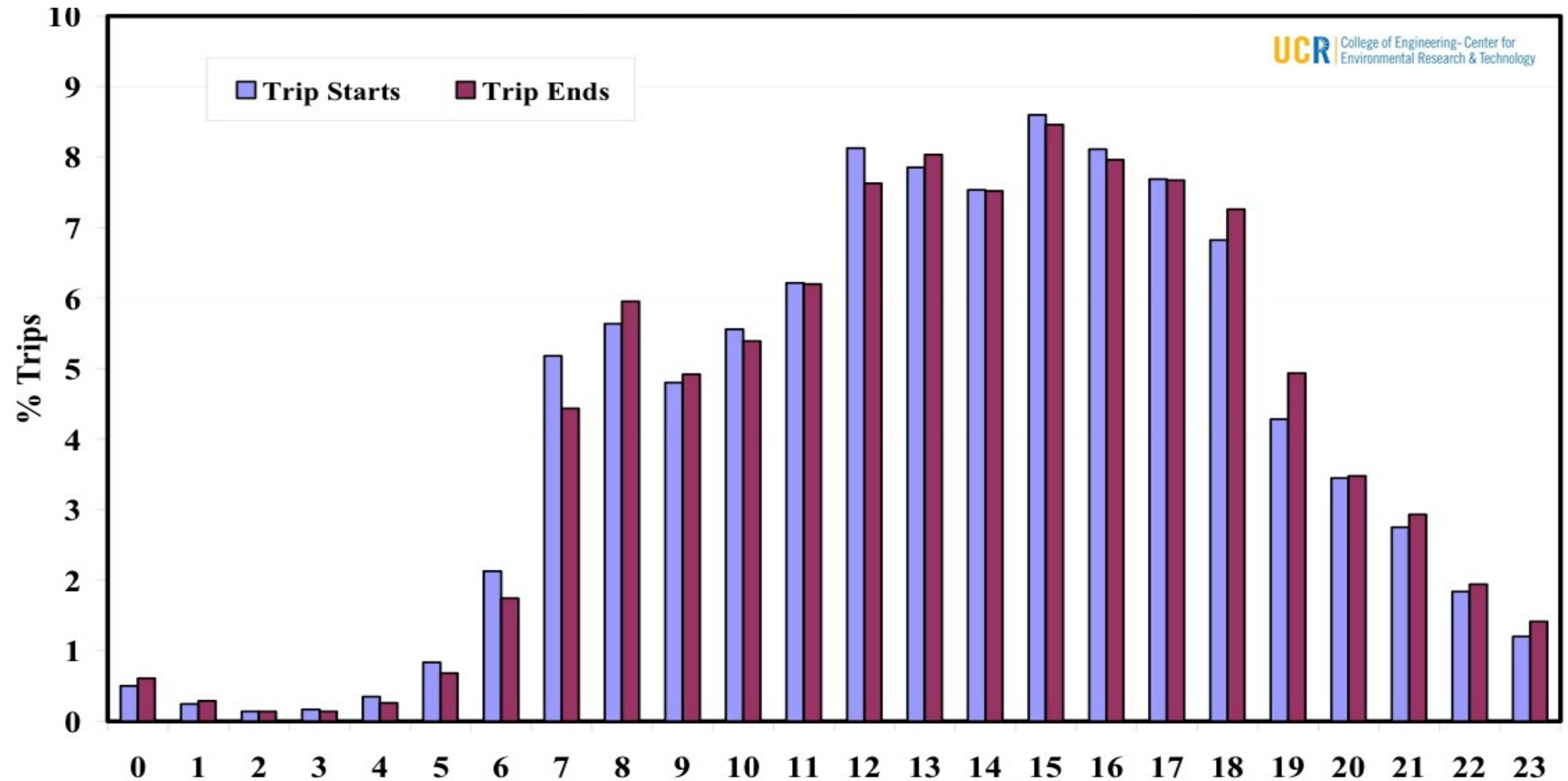
60 miles per hour

Solar Powered

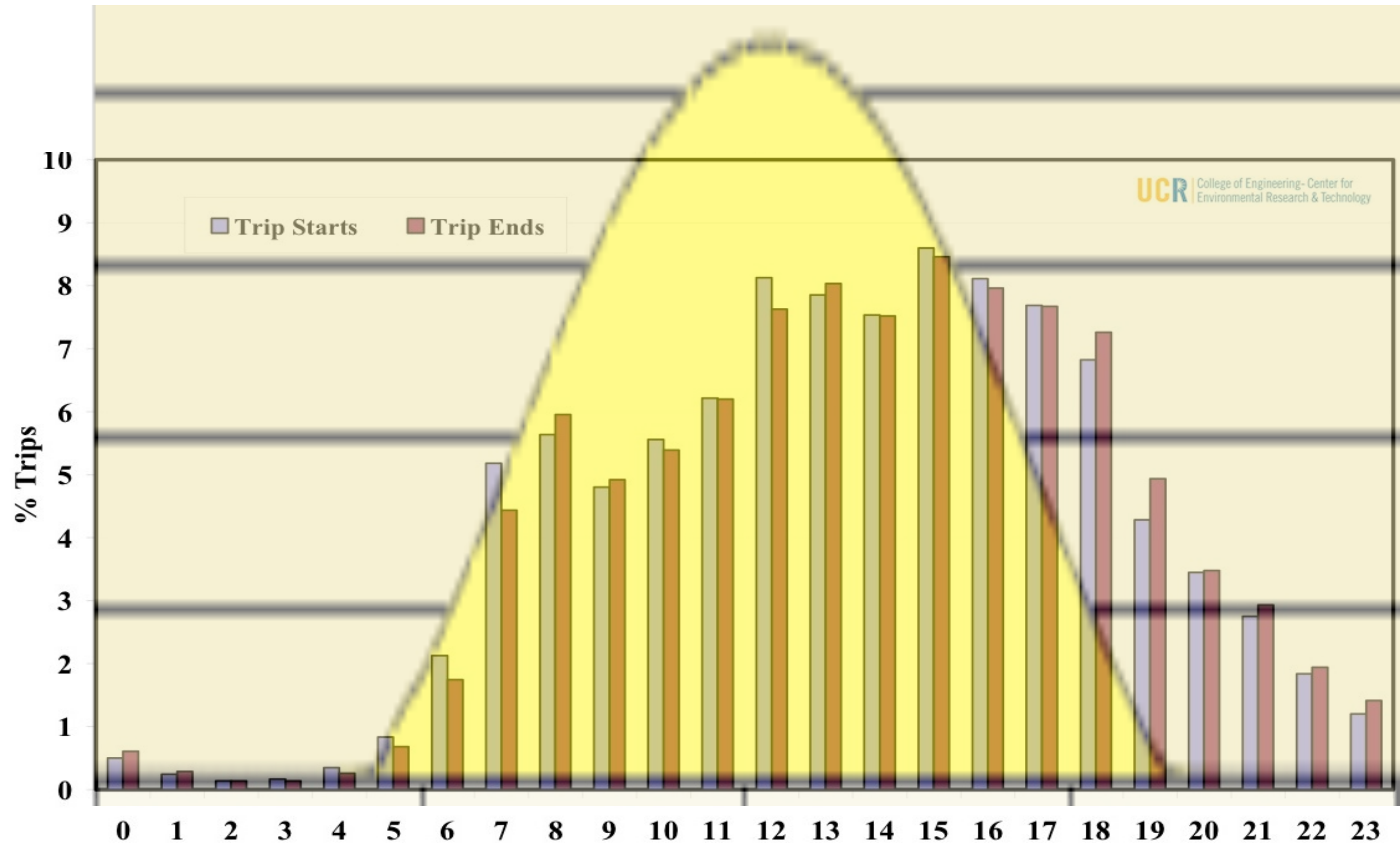
80 metres car-spacing

= **5 metres wide**

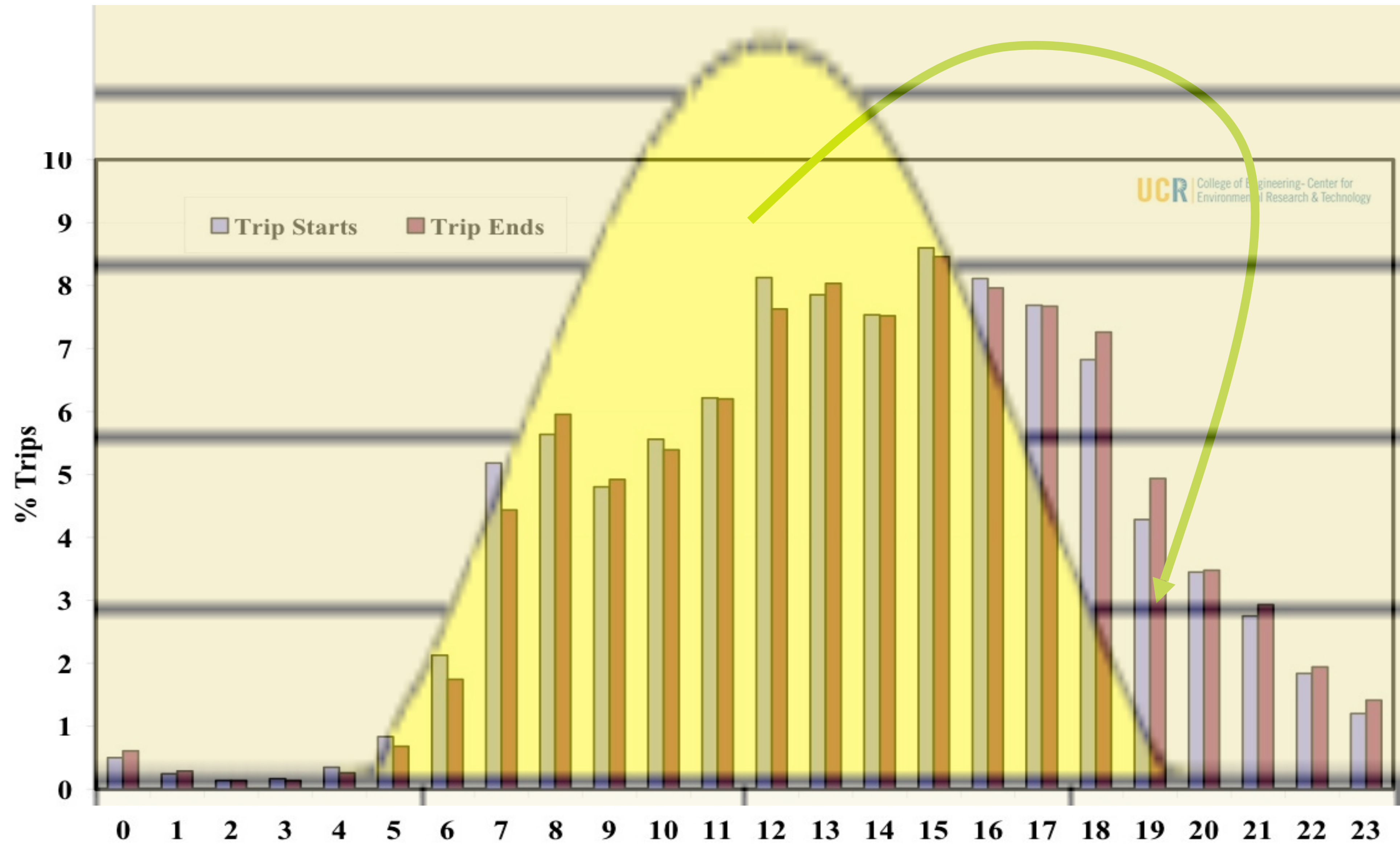
Typical trip patterns closely match the pattern of sunshine, with evening extension



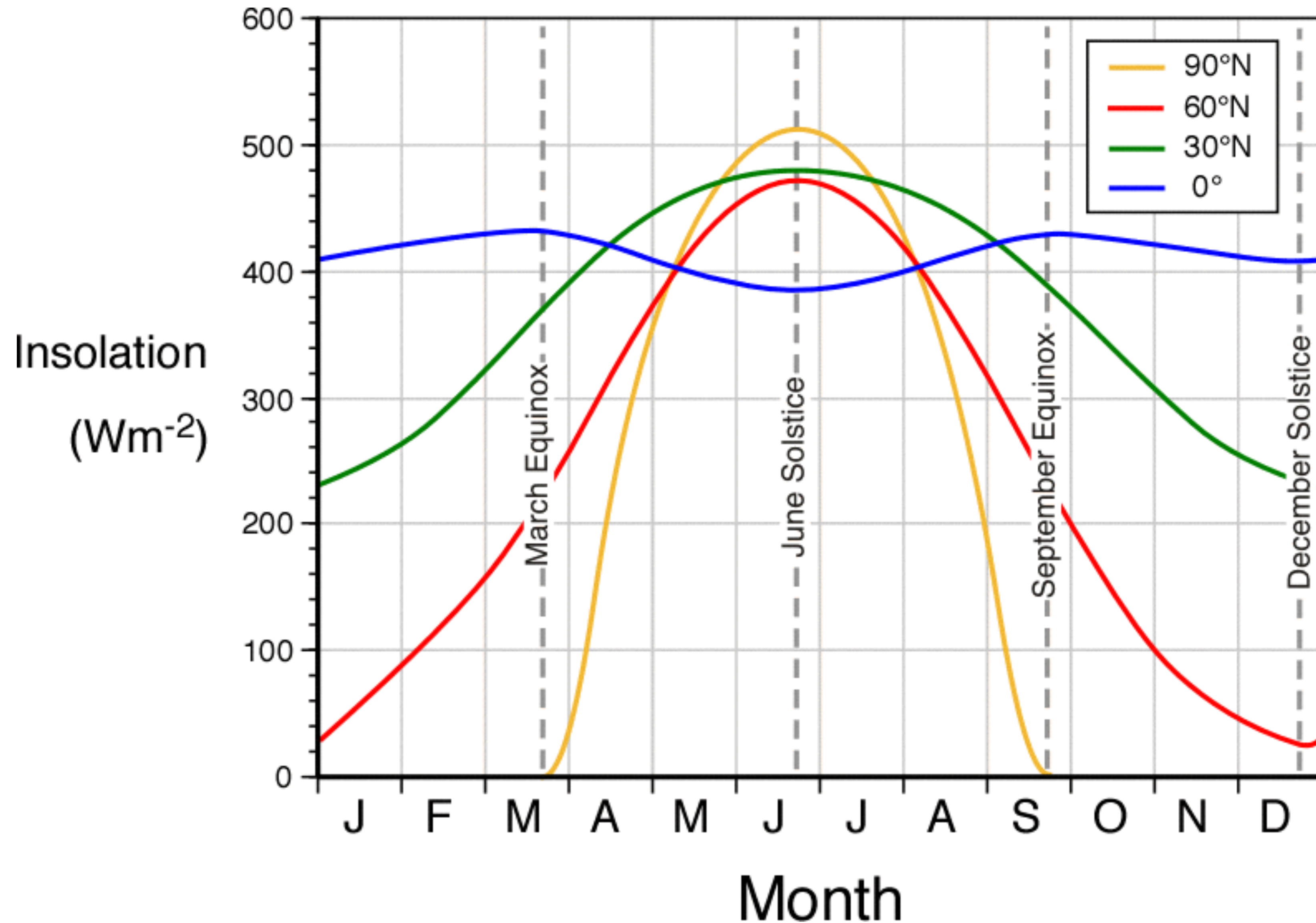
Typical trip patterns closely match the pattern of sunshine, with evening extension



Typical trip patterns closely match the pattern of sunshine, with evening extension

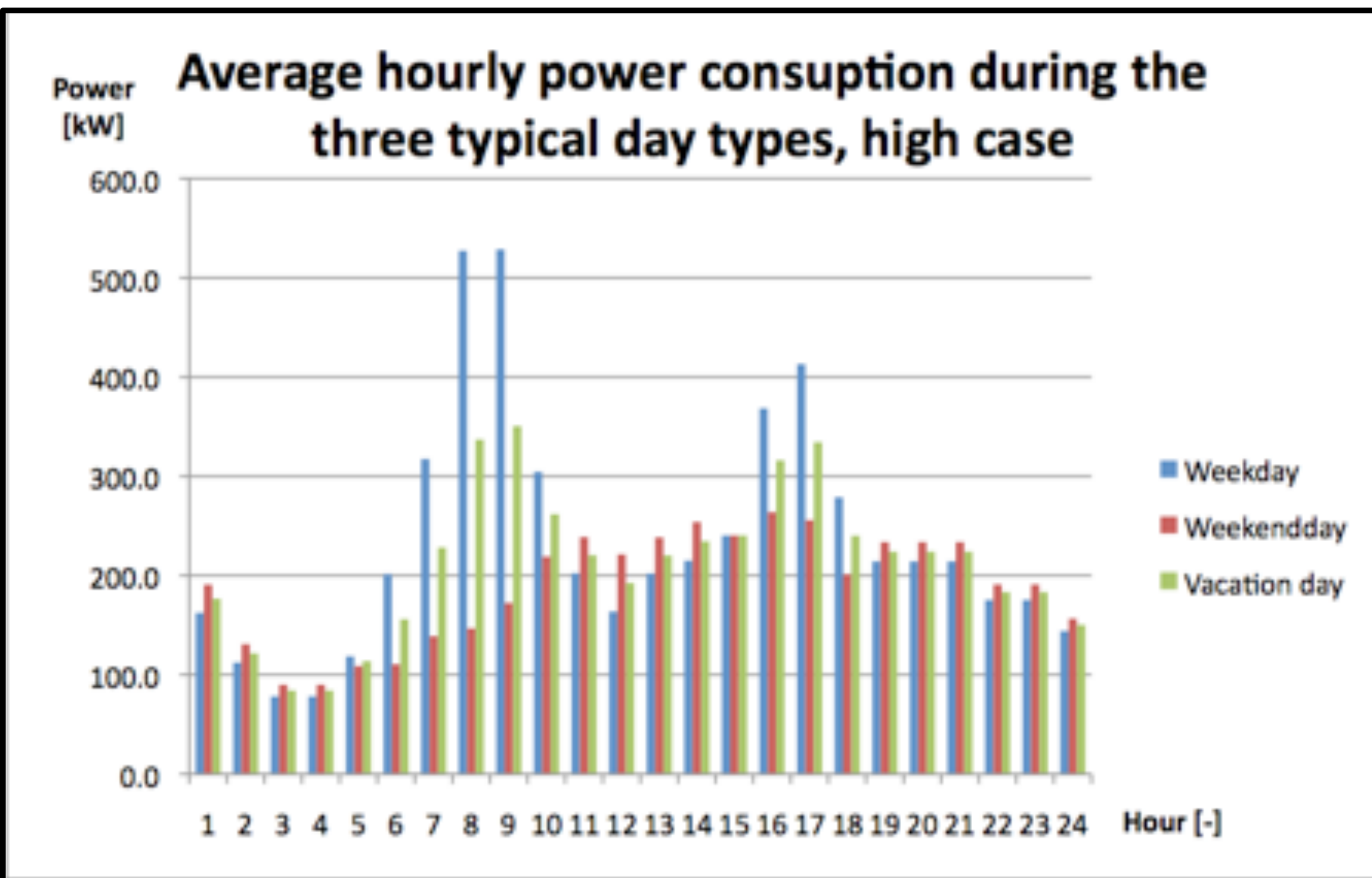


Is solar possible? Let's start with the tough case: 2/3 of the way to the north pole

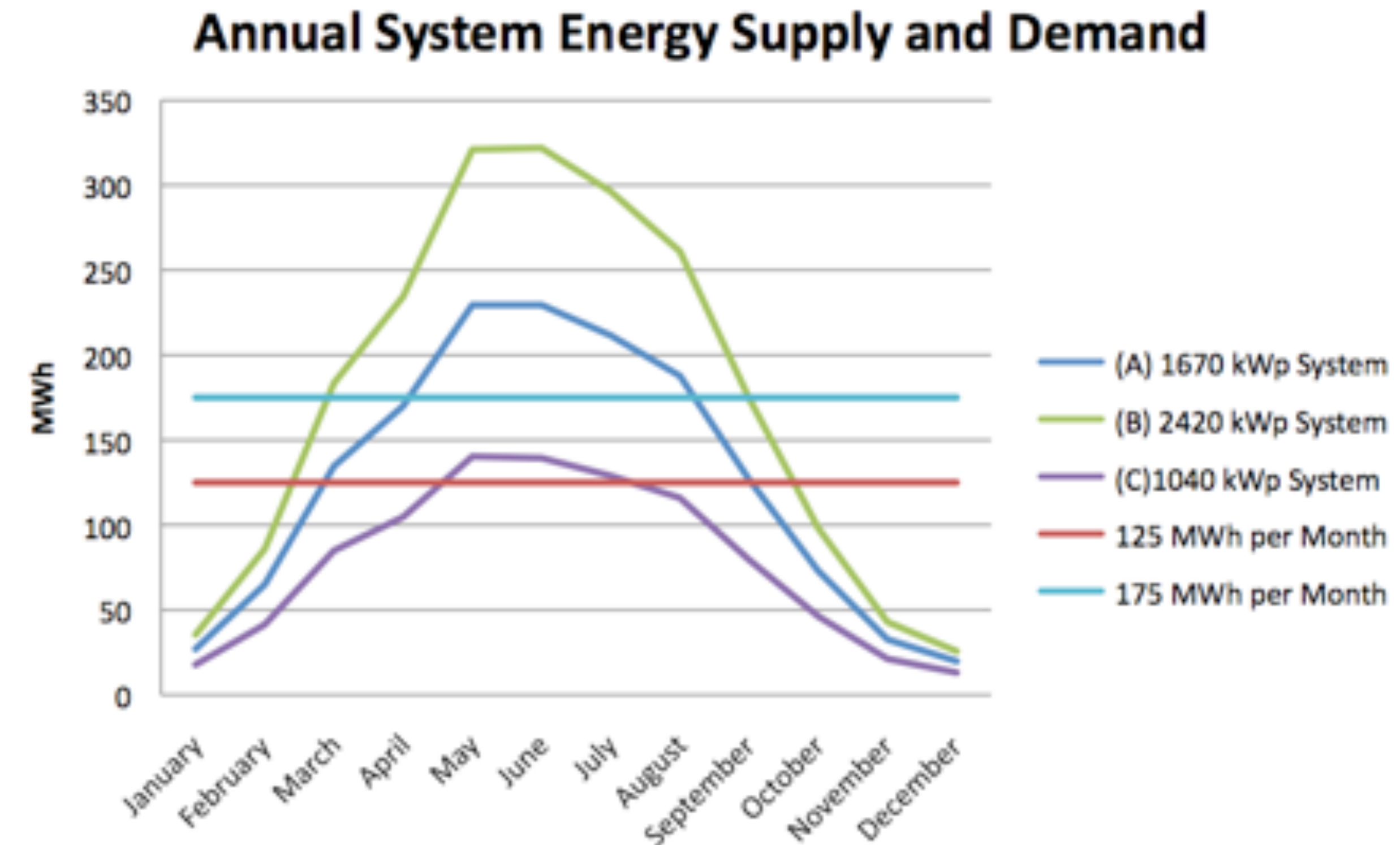
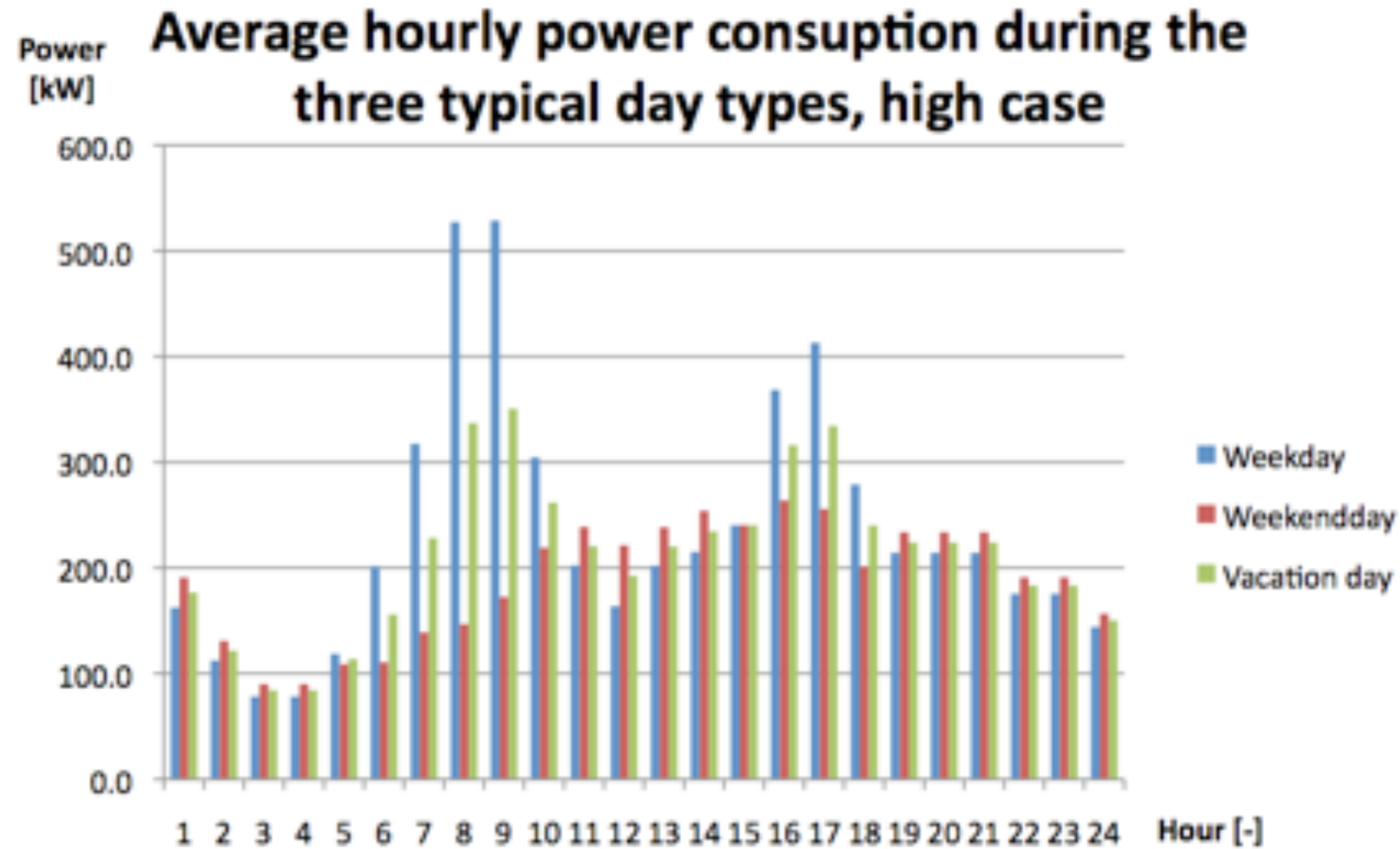


With a megawatt a mile, solar can deliver 20,000 trips per day, even in Sweden

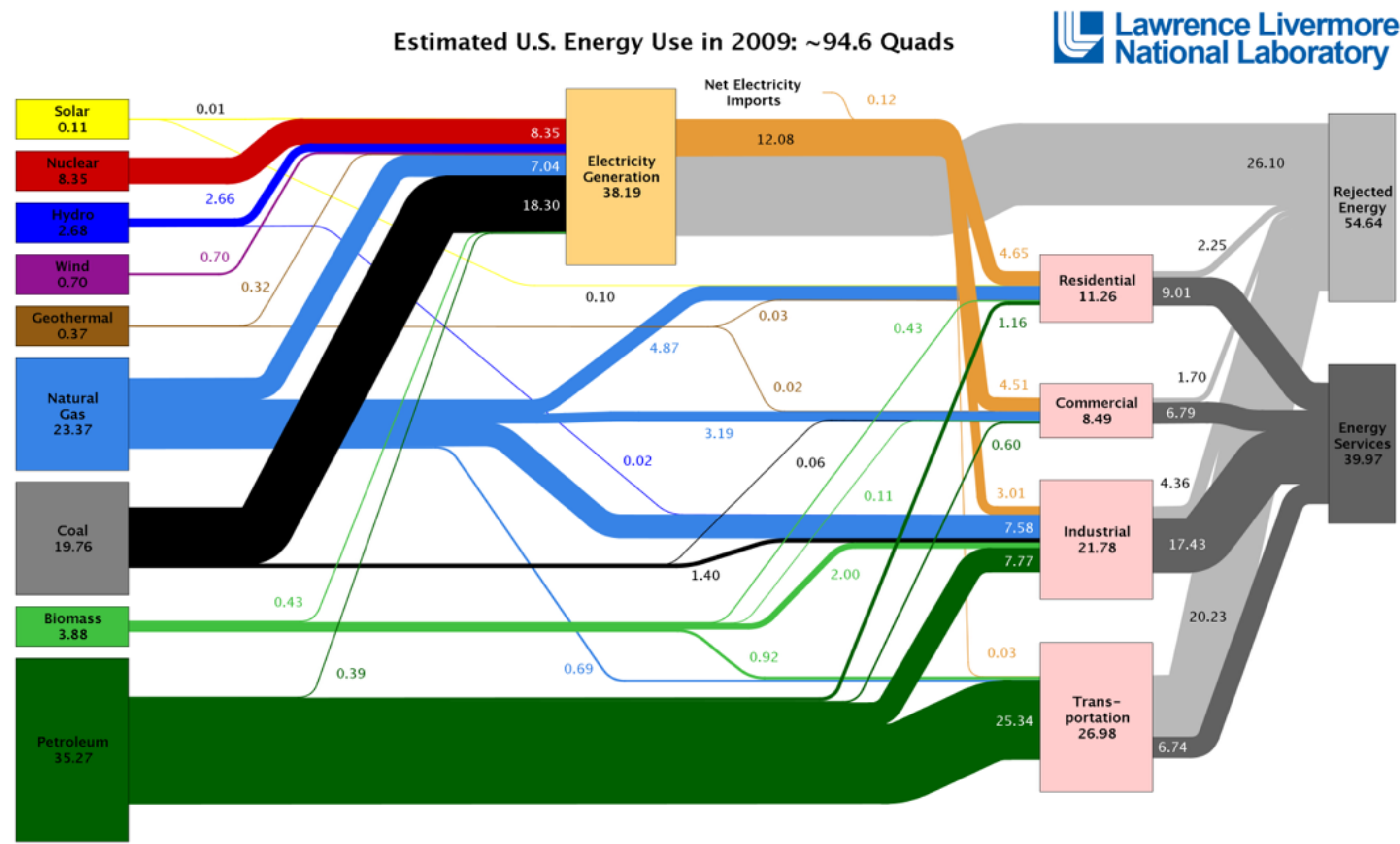
With a megawatt a mile, solar can deliver 20,000 trips per day, even in Sweden



With a megawatt a mile, solar can deliver 20,000 trips per day, even in Sweden



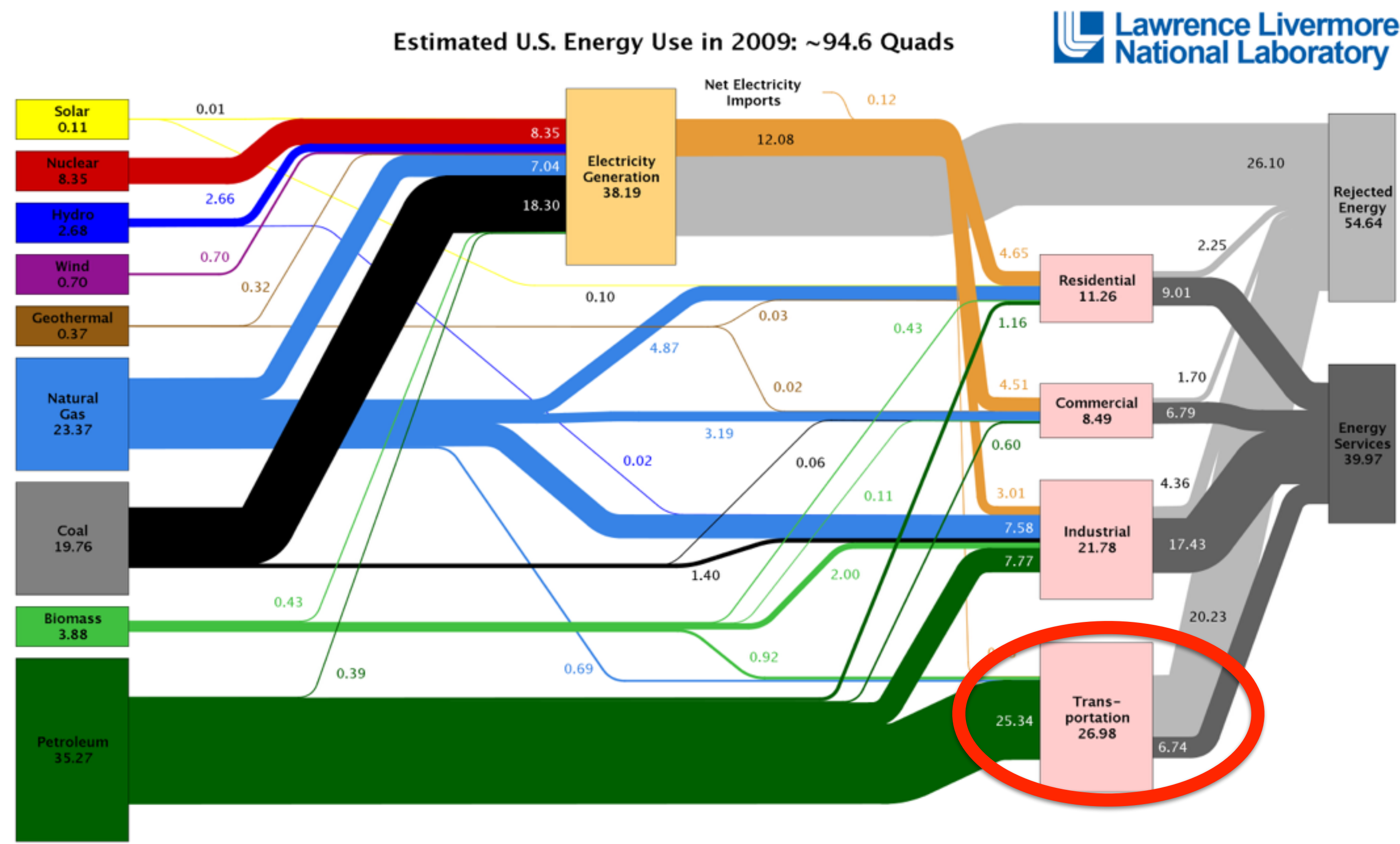
One TeraWatt of solar is enough for transportation



Source: LLNL 2010. Data is based on DOE/EIA-0384(2009), August 2010. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527



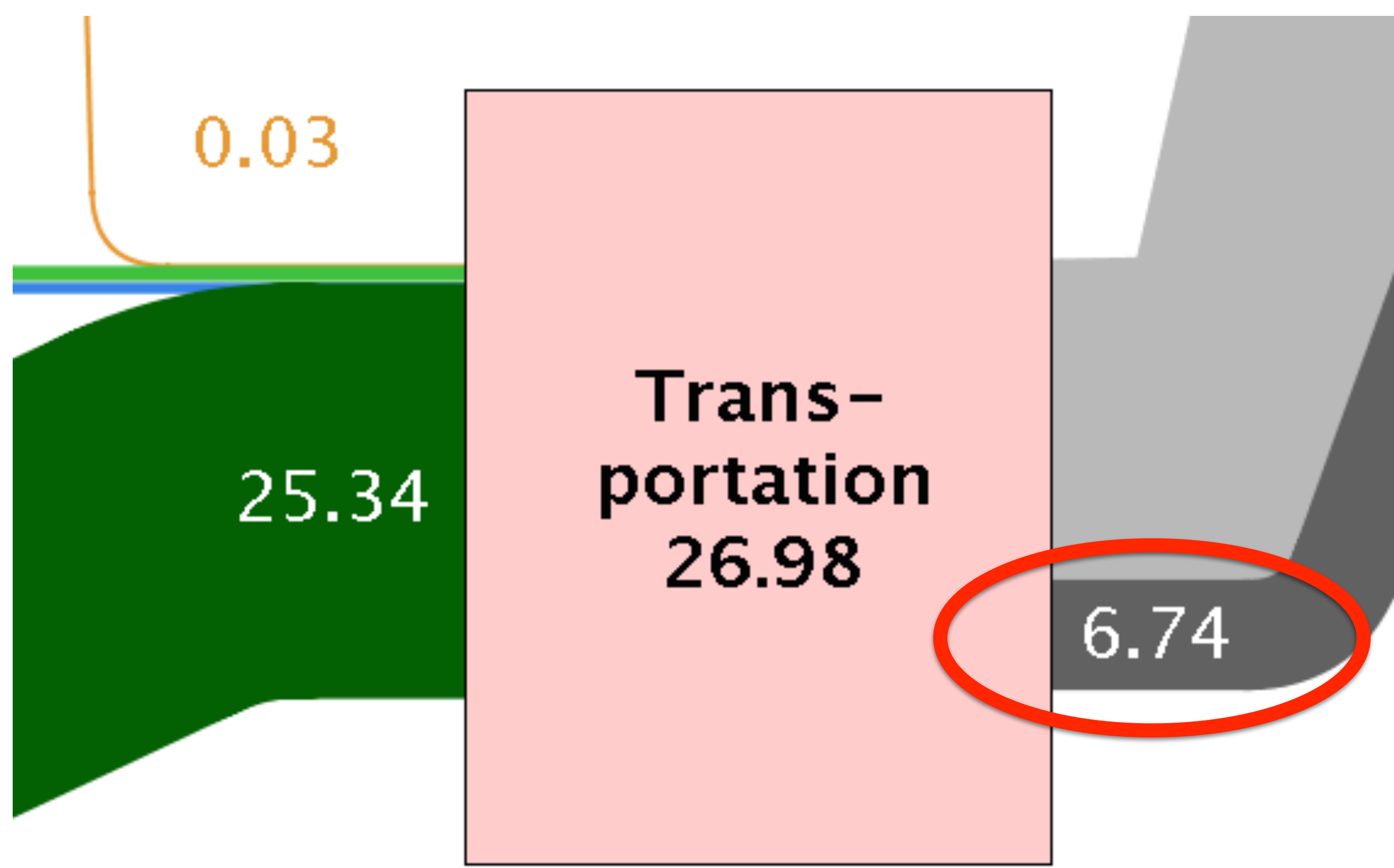
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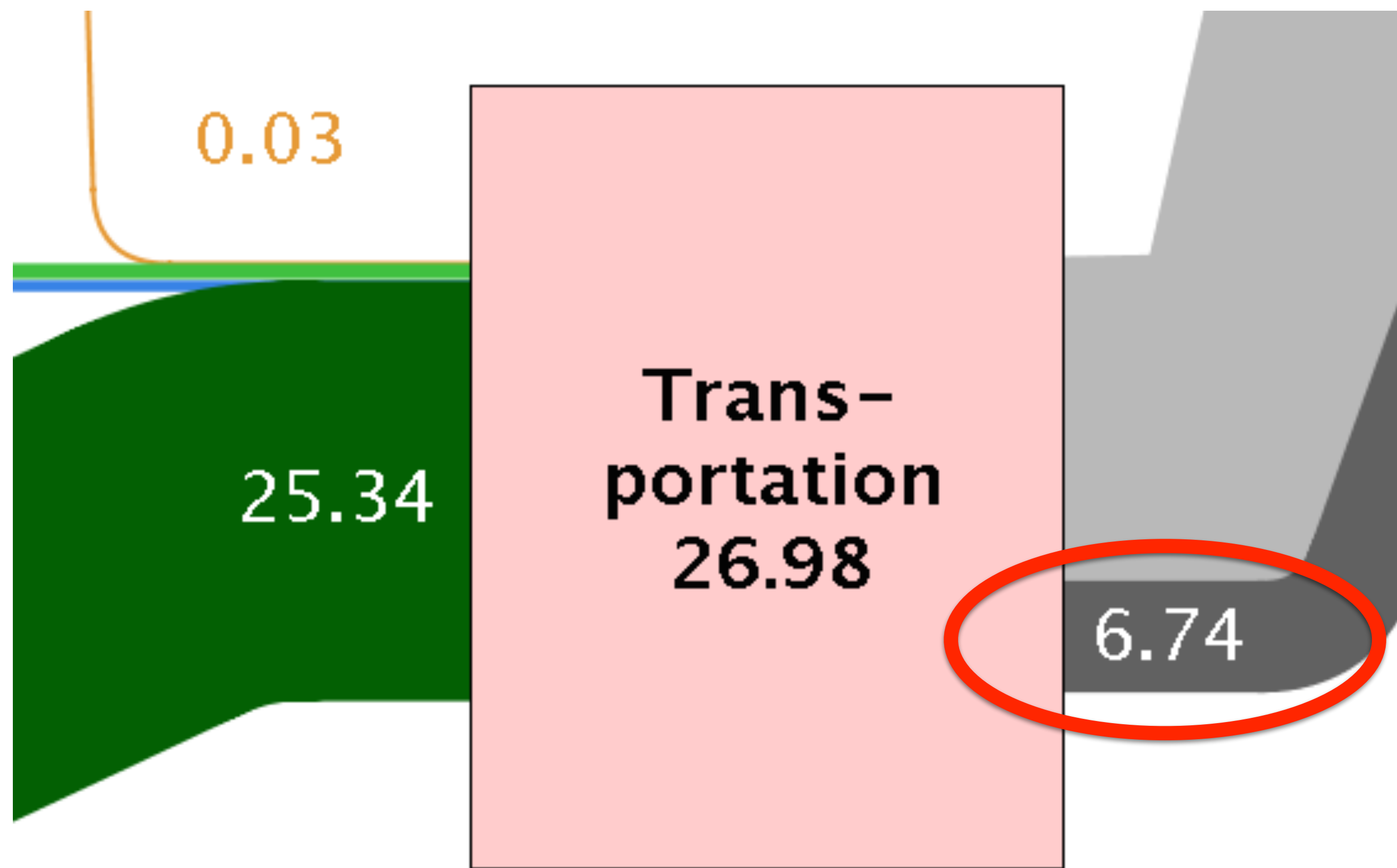
Source: LLNL 2010. Data is based on DOE/EIA-0384(2009), August 2010. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527



One TeraWatt of solar is enough for transportation



One TeraWatt of solar is enough for transportation



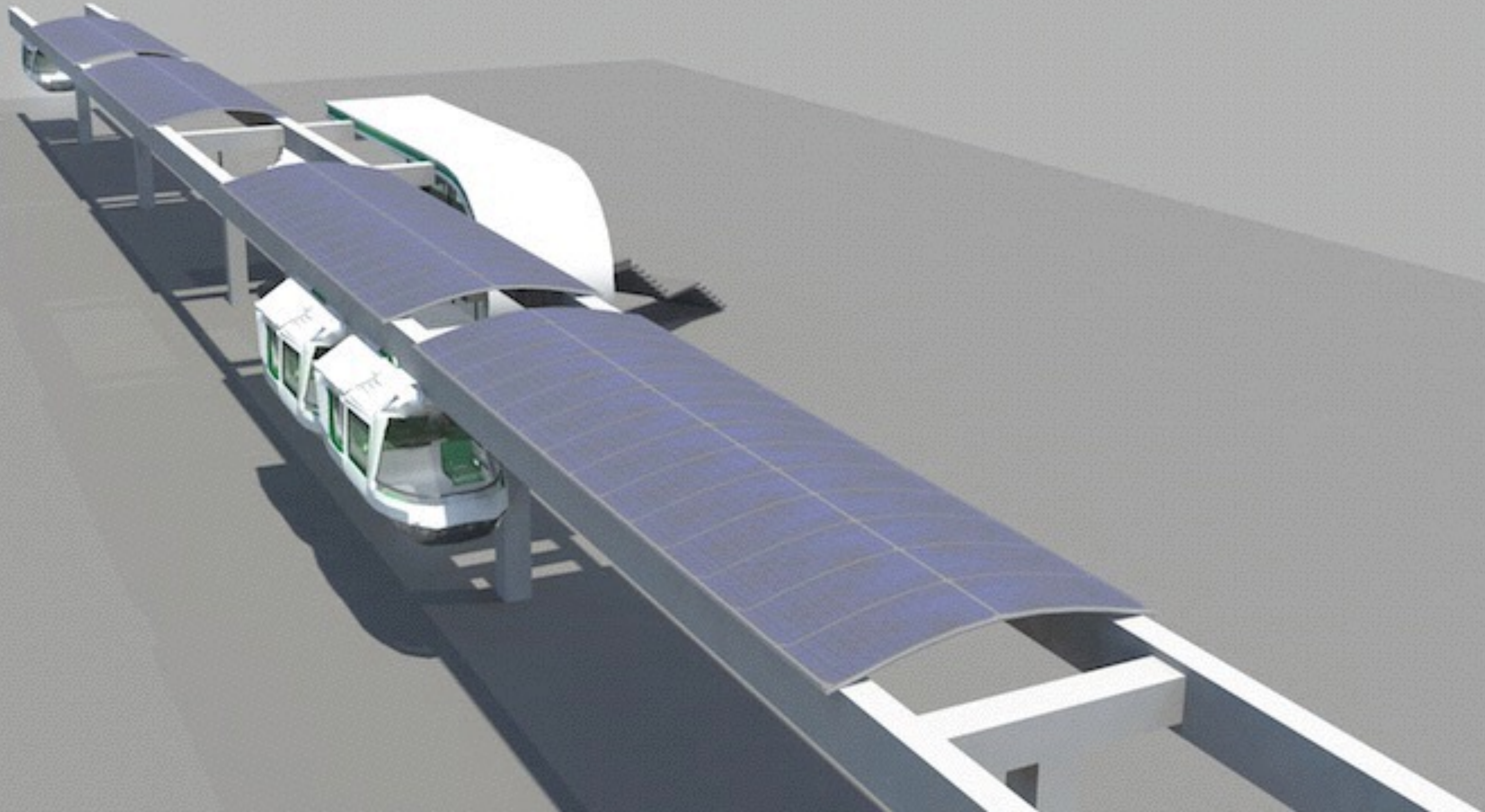
**1 tw x 5 hours/day =
6.25 Quad/year =
net useful energy for
transportation. With
efficiency gain of 5X,
there will be surplus
energy for the grid.**

**With suspended vehicles, inclusion of solar is easy,
as illustrated by this recent project**

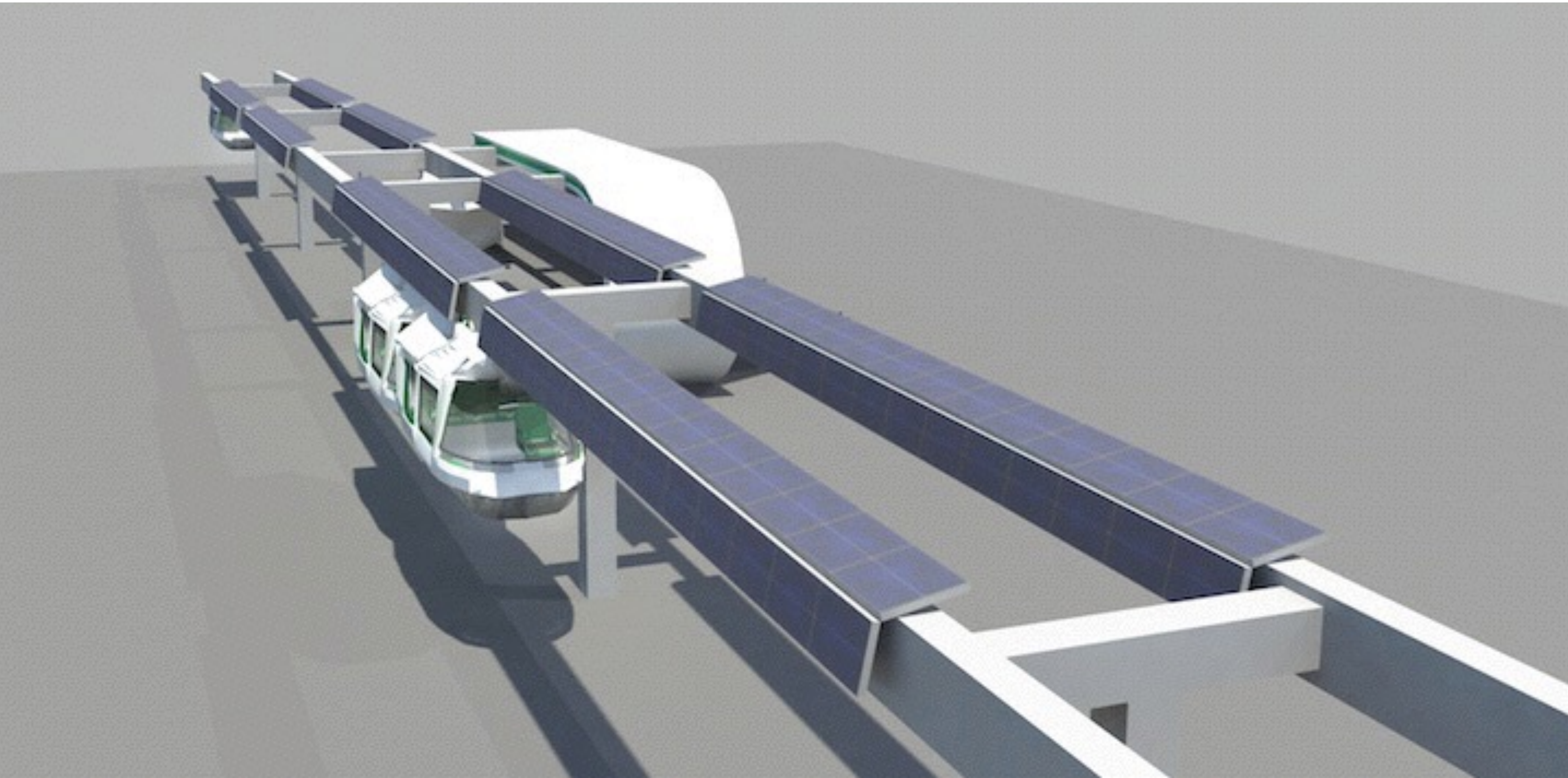


Swenson Solar

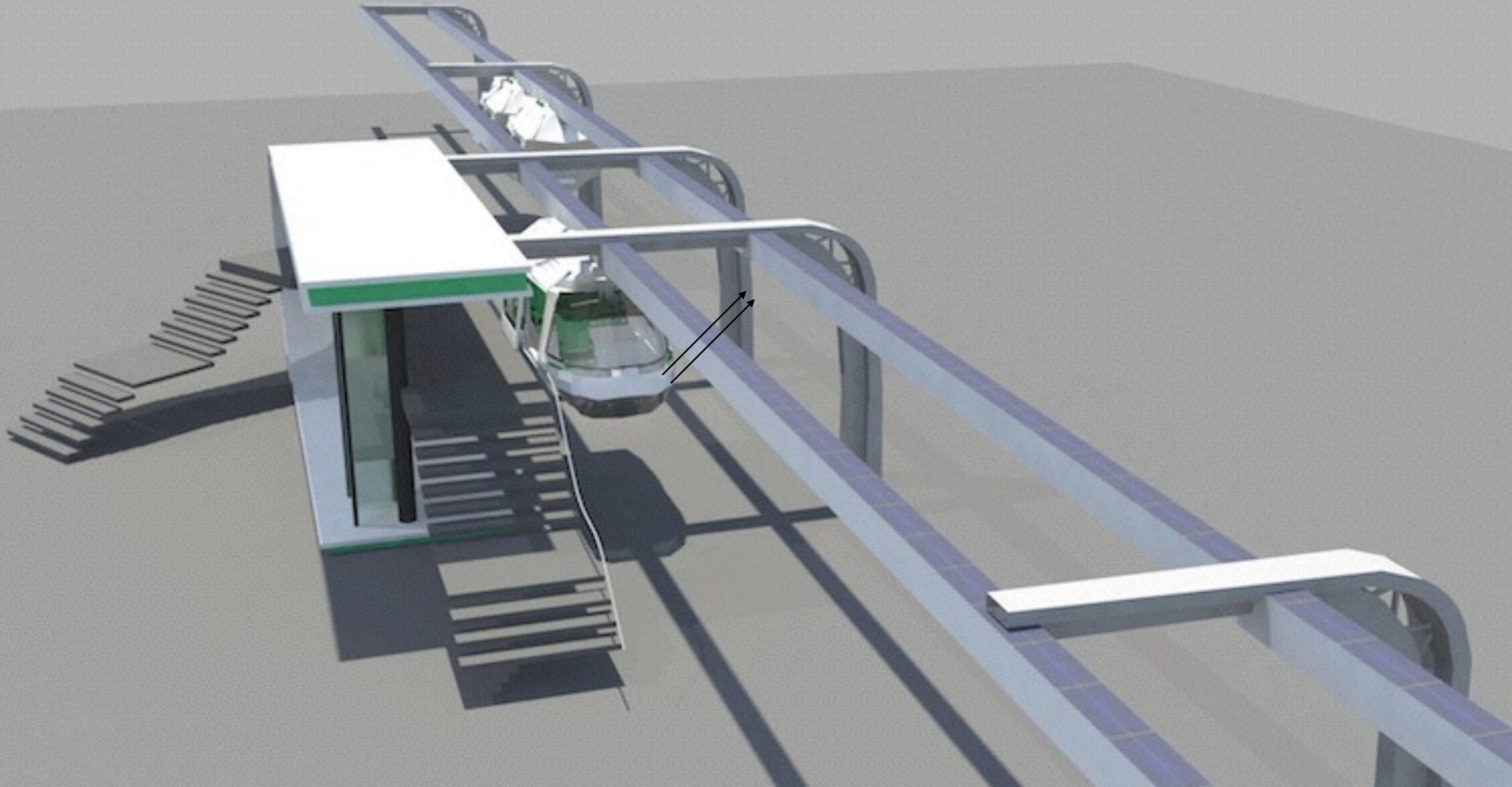
What about the visual impact of the solar array?



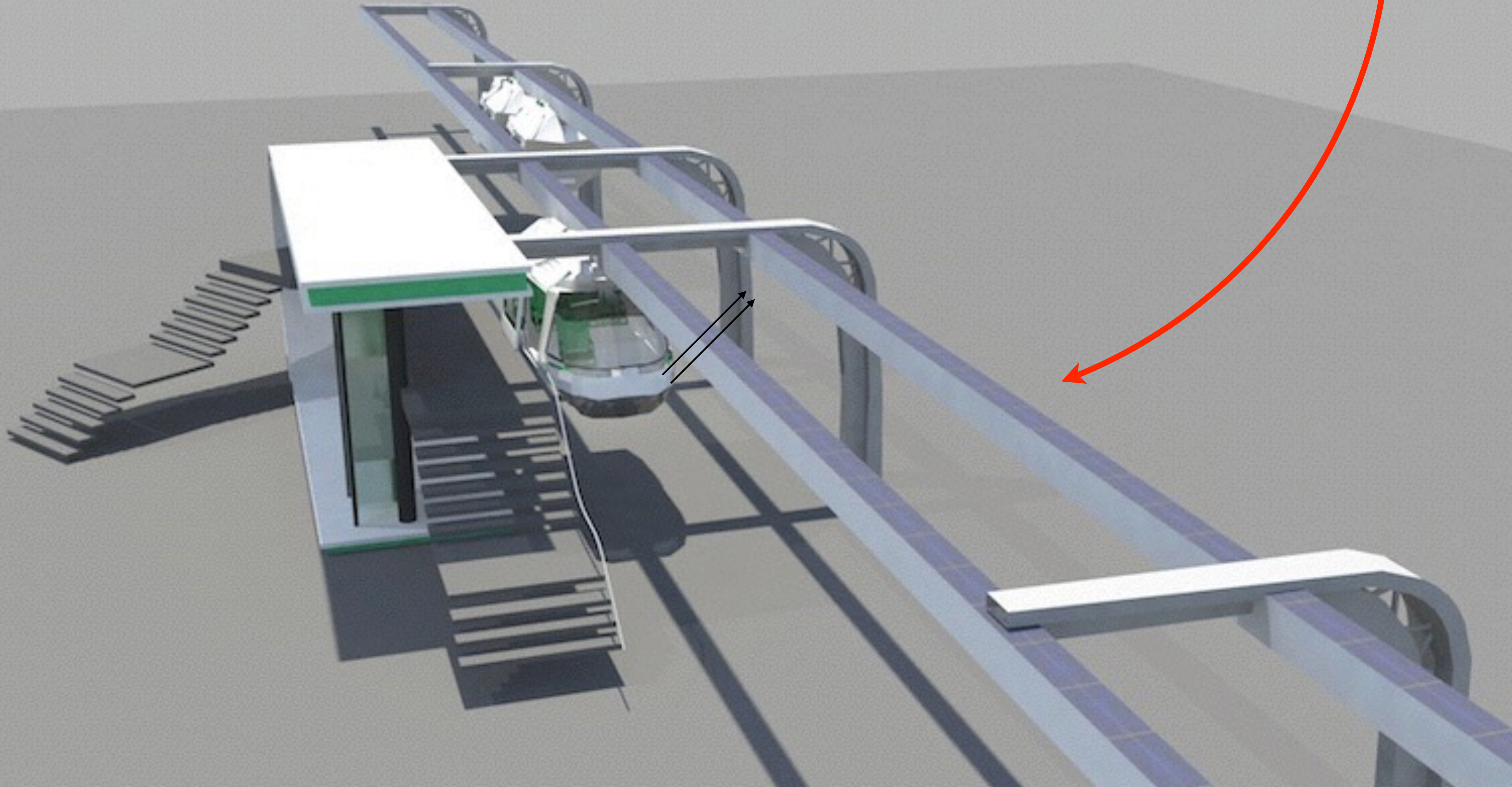
Where necessary, the solar array can be *narrower*



Where necessary, the solar array can be *minimal*



Where necessary, the solar array can be ***minimal***



We also helped Santa Cruz envision ATN



We are making progress in Santa Cruz



History of Solar Skyways

JPods patented solar podcars in 2004

1) managing emergency conditions in accordance with said protocol to safely complete said trip.

9. The method claimed in 8 said trip further comprising:

a) accumulating time based availability of said devices by said negotiators;

b) scheduling and executing said trips to position vehicles in response to historical demand for trips

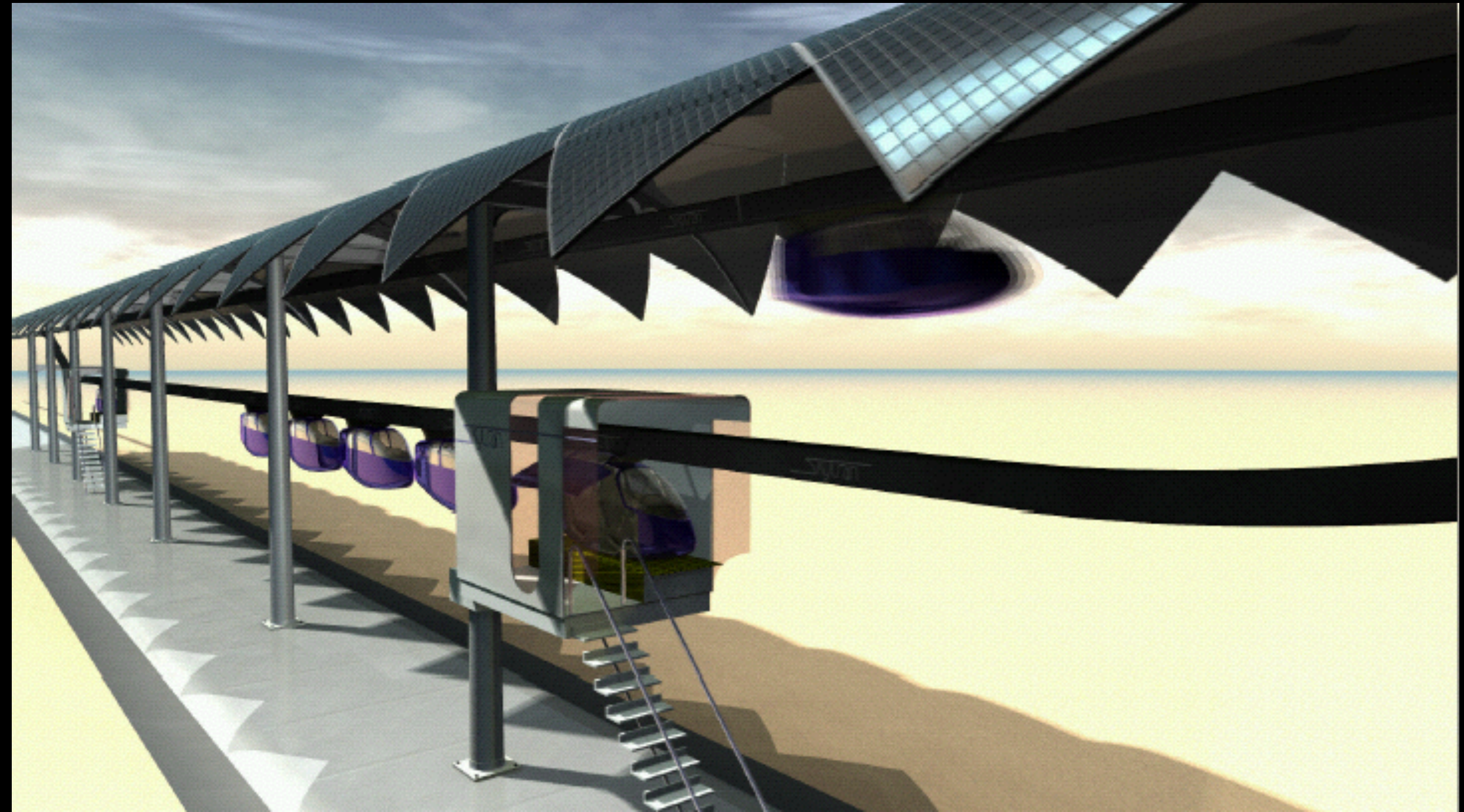
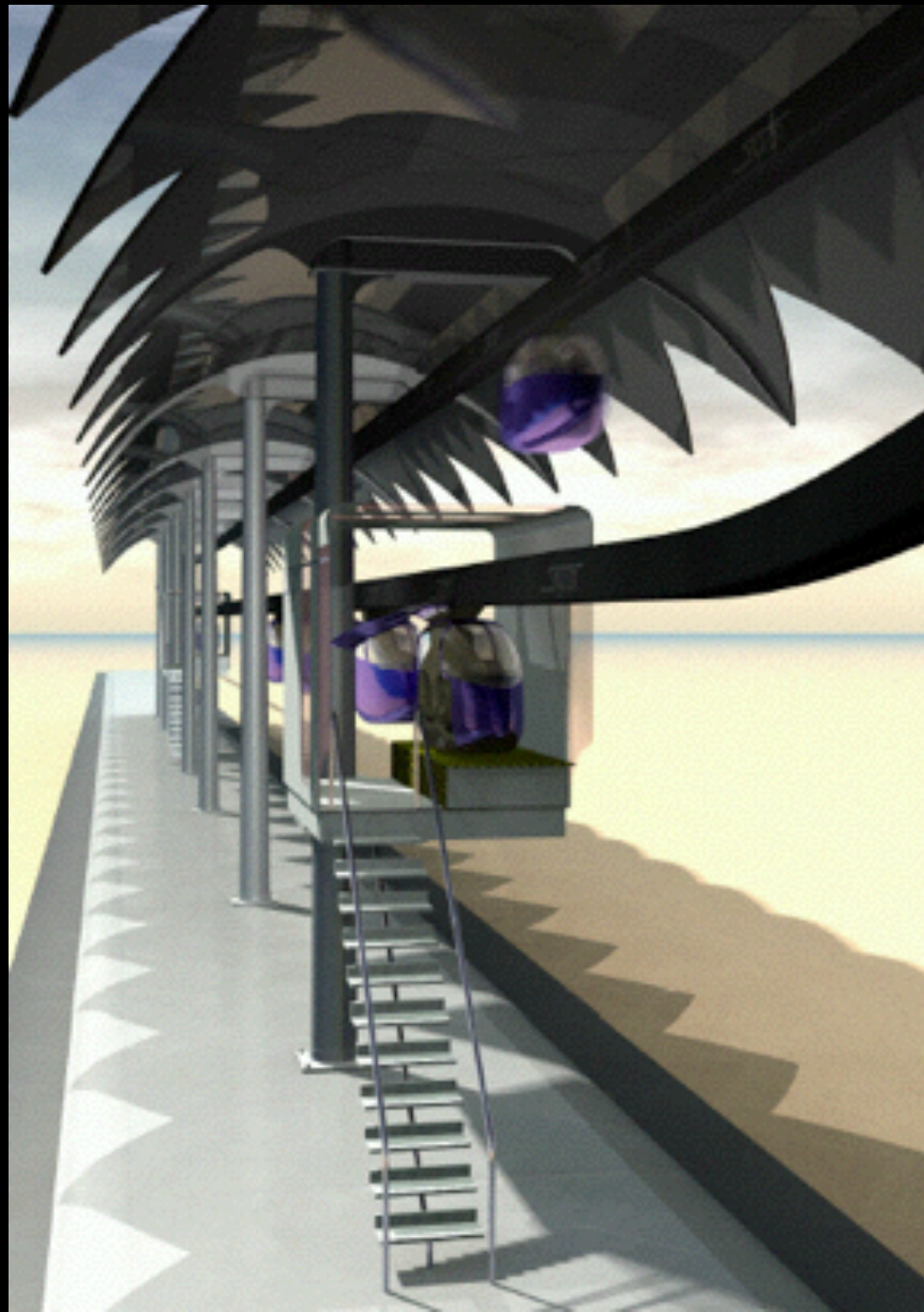
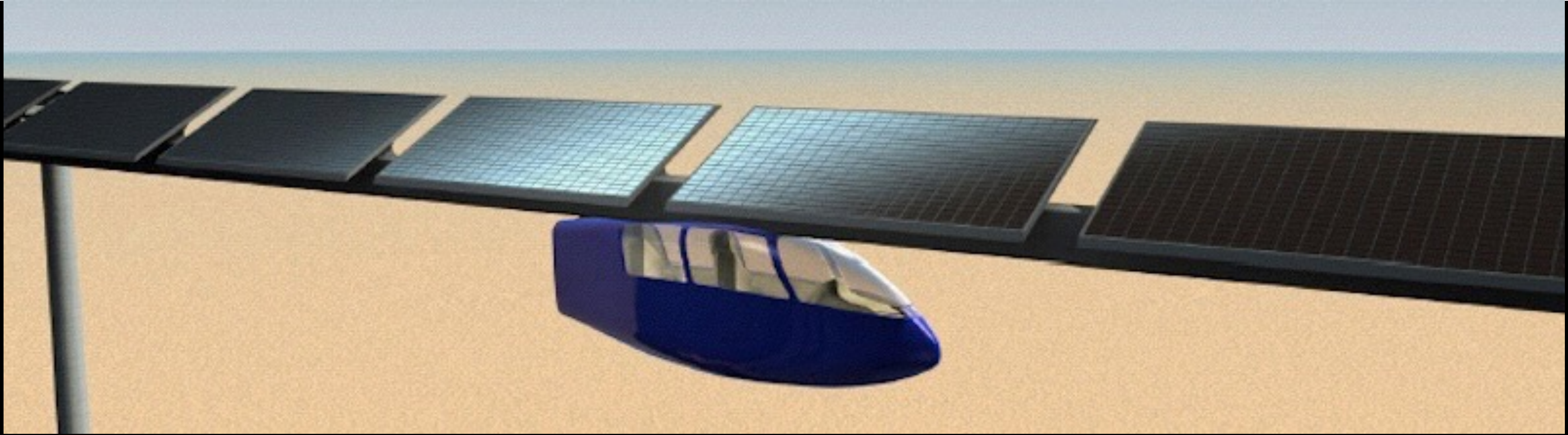
10. The method claimed in 1 said first power means further comprising:

a) providing a second power means which enables transferring said power sources from an electric power grid to said vehicles and said transportation system;

b) providing a third power means comprising solar and wind power generators integrated into the physical structure of said transportation system augmenting first power means.

11. A method of managing a transportation system for moving people, freight, and any combination thereof using

In 2006 a practical solar mobility solution was discovered



2006

We created a solar visualization in 2007



**Swenson Solar built an ATN-equivalent guideway
that is aesthetically pleasing**



Swenson Solar

2011

We are seeing more and more solar visualizations



We are seeing more and more solar visualizations

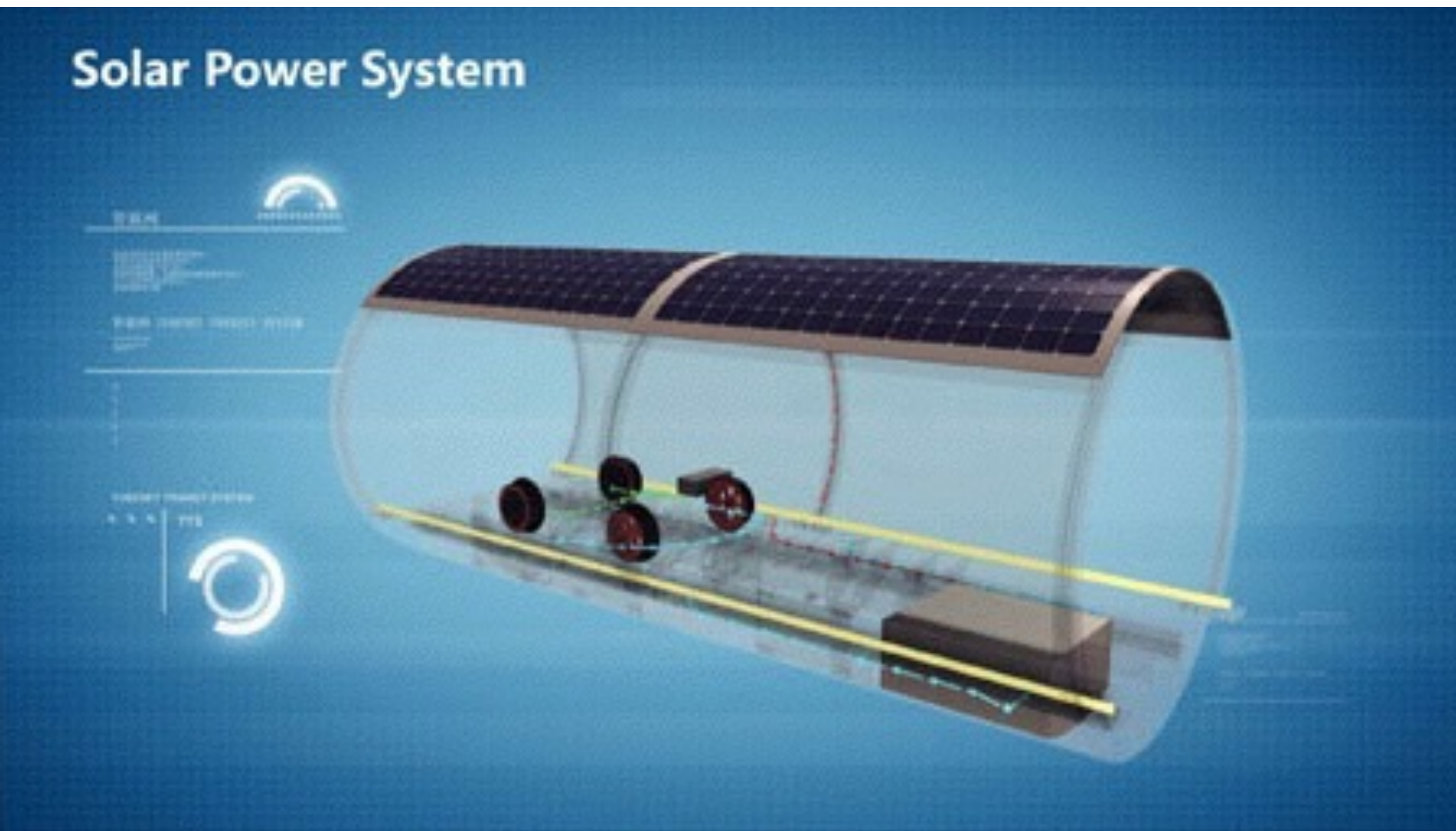


Figure 6
Terminal B ATN Station Conceptual Illustration
3D Rendering - Station View 1

San José ATN Feasibility Study

July 26, 2012

We are seeing more and more solar visualizations



INIST is coordinating a three sector program

Universities



INIST is coordinating a three sector program

Universities

Cities



INIST is coordinating a three sector program

Universities

Cities

Industry



INIST is coordinating a three sector program

Universities

Cities

Industry



Universities

Cities

Industry



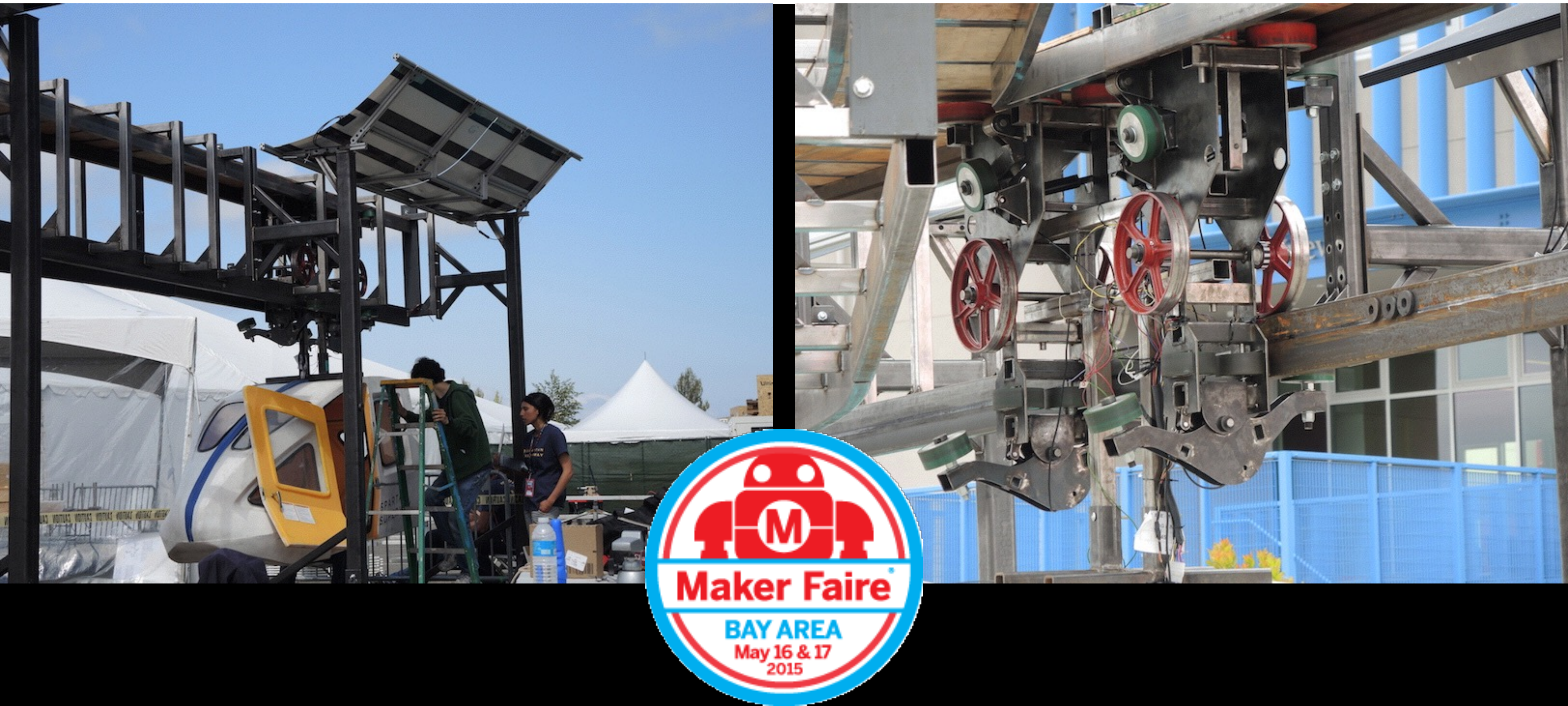
The basic concept was demonstrated at Intersolar in San Francisco in 2014



In May 2015, the Spartan Superway team returned to Maker Faire with a full scale prototype



In May 2015, the Spartan Superway team returned to Maker Faire with a full scale prototype



Solar Skyways can happen with international collaboration



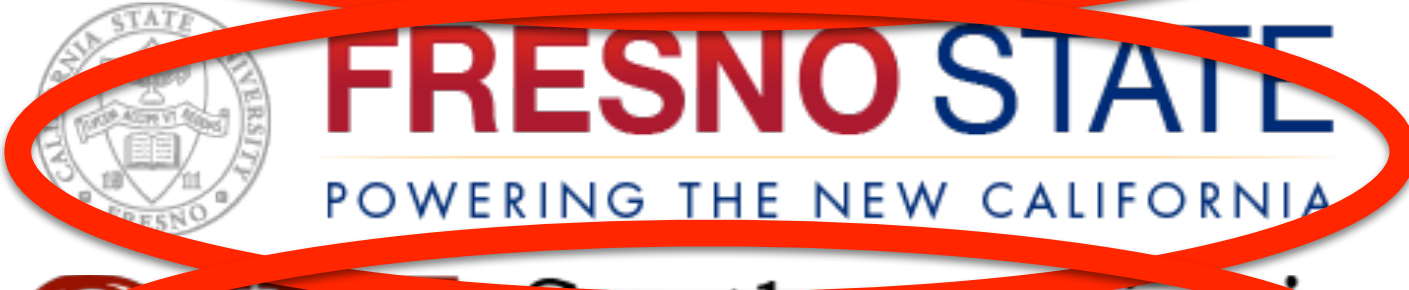






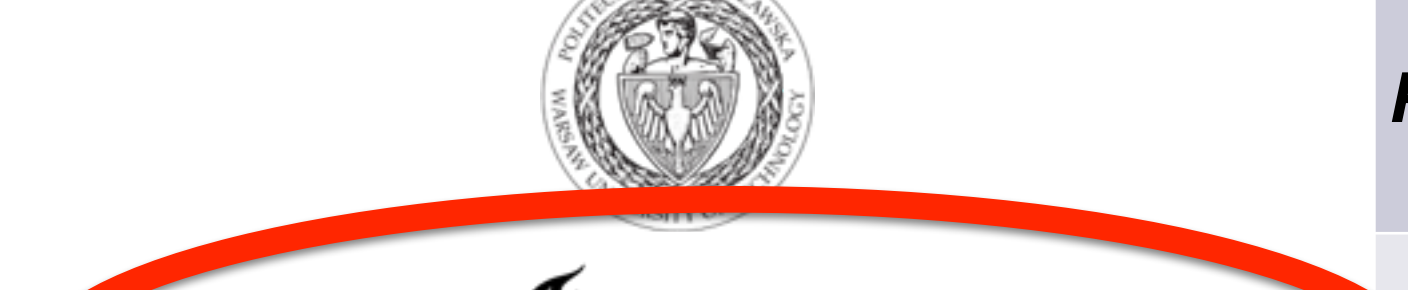








Universities are working together – around the country and around the world



San José	 UPPSALA UNIVERSITET	Sweden
Fresno	 LINKÖPING UNIVERSITY	Sweden
Illinois	 KUNGL TEKNISKA HÖGSKOLAN	Sweden
Santa Cruz	 UNIVERSIDAD PANAMERICANA Guadalajara	Mexico
Santa Clara		Poland
San Francisco	 TU Delft Delft University of Technology	Netherlands
Merced	 INSA LYON	France
South Carolina	 EMLU EXECUTIVE DEVELOPMENT	France

Universities are working together – around the country and around the world

	San José		Sweden
	Fresno		Sweden
	Illinois		Sweden
	Santa Cruz		Mexico
	Santa Clara		Poland
	San Francisco		Netherlands
	Merced		France
	South Carolina		France

Join us and...

*FAST
ABOVE!!*

iNiST

**We invite you to join us.
Thank you for your attention!**



www.inist.org

www.podcity.org



www.superway.us



www.gofundme.com

**Automated Transportation
Network Association**

www.atna.us