# The 2000-Watt Society & Passive House

Duluth Energy Design Conference & Expo 2022

STUDIO

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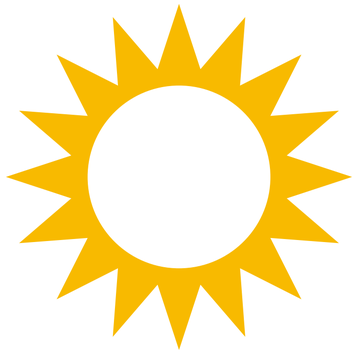
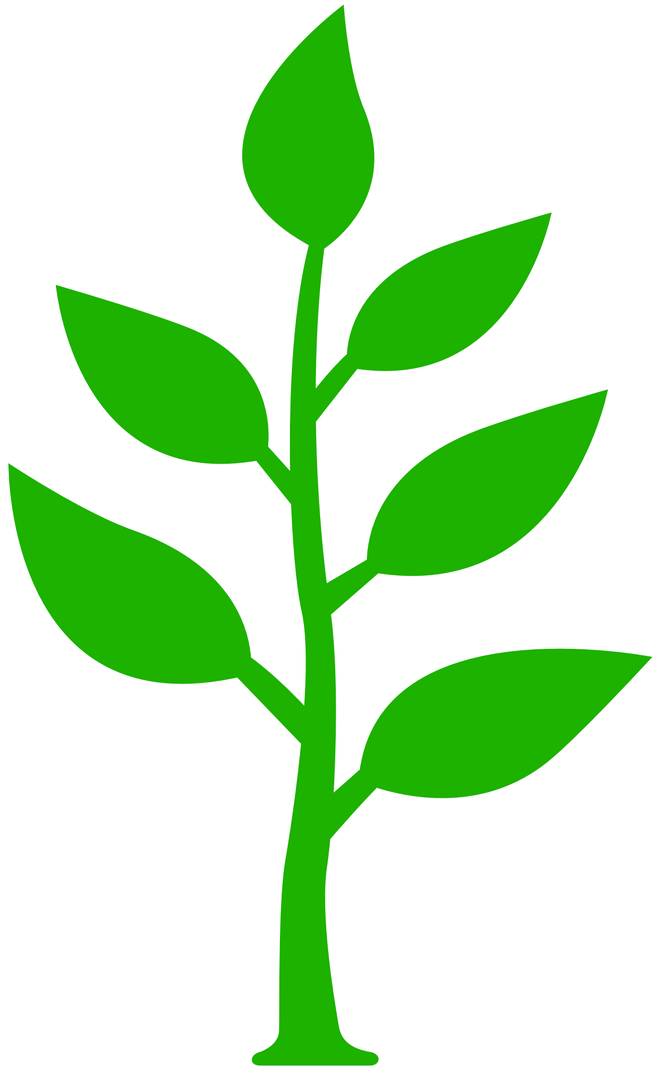
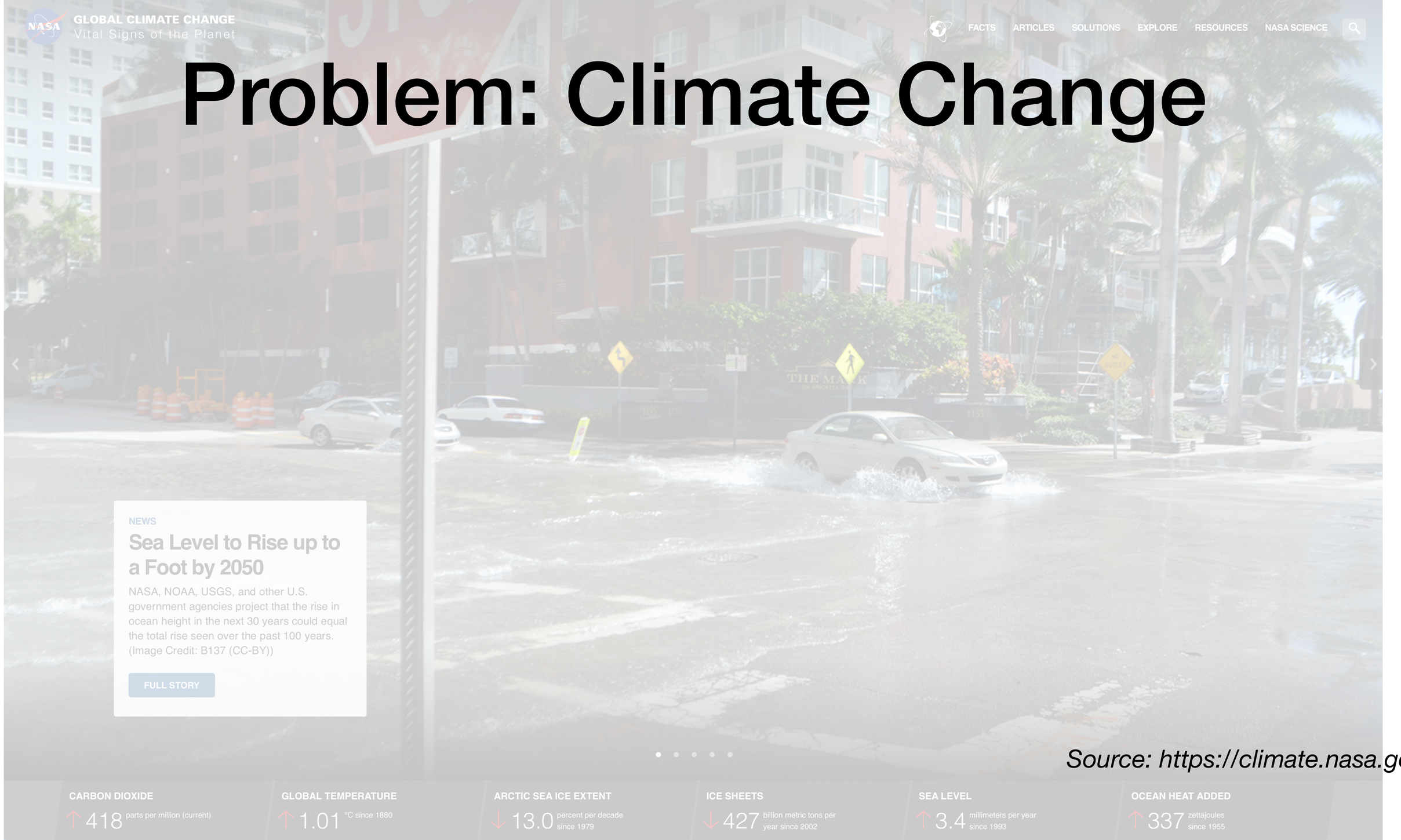
Principal TE Studio, Dipl.-Ing., Certified Passive House Designer

# Energy is Life



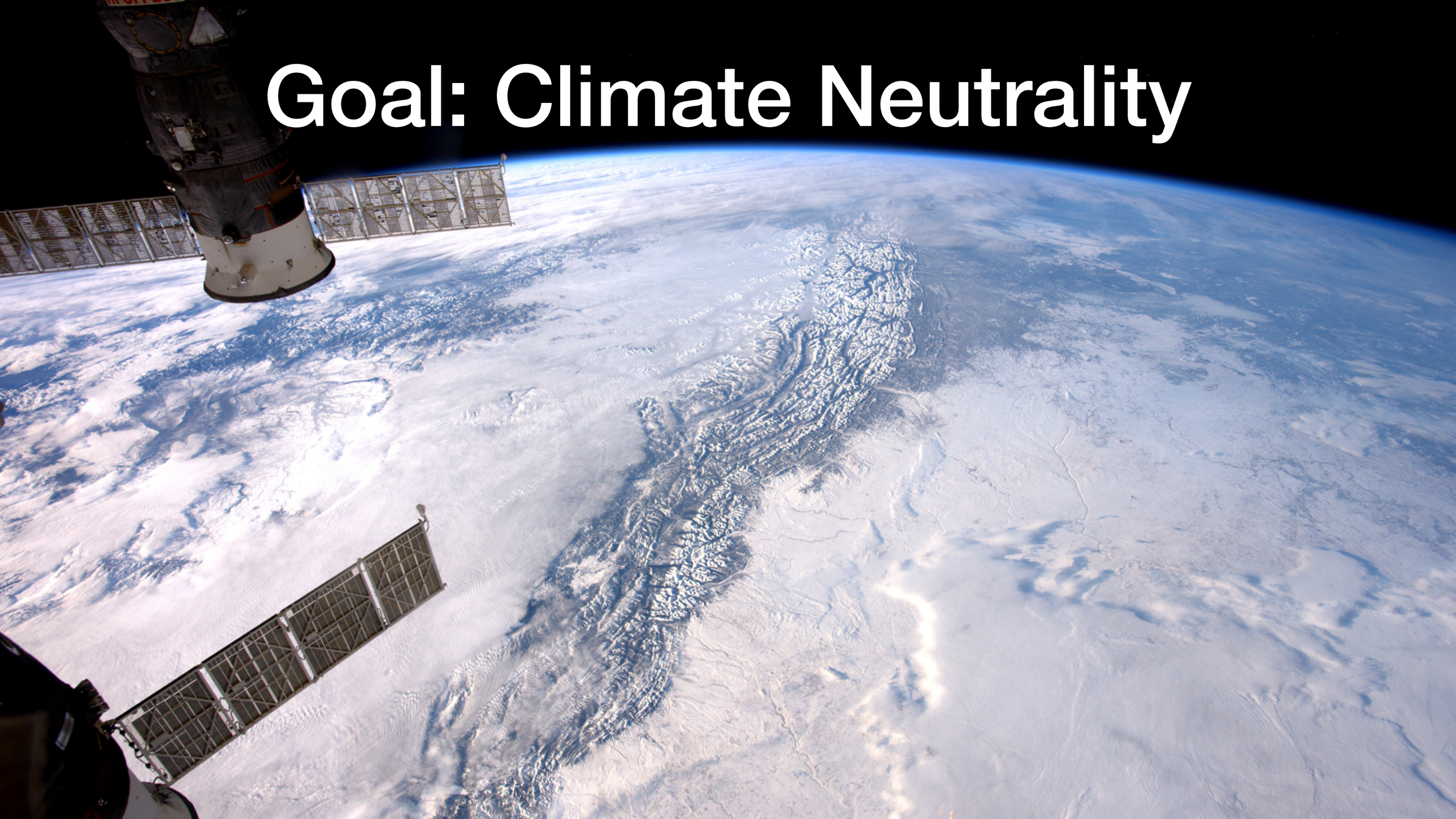





# Problem: Climate Change

*Source: https://climate.nasa.gov*

# Goal: Climate Neutrality



# IPCC: Red Alert!

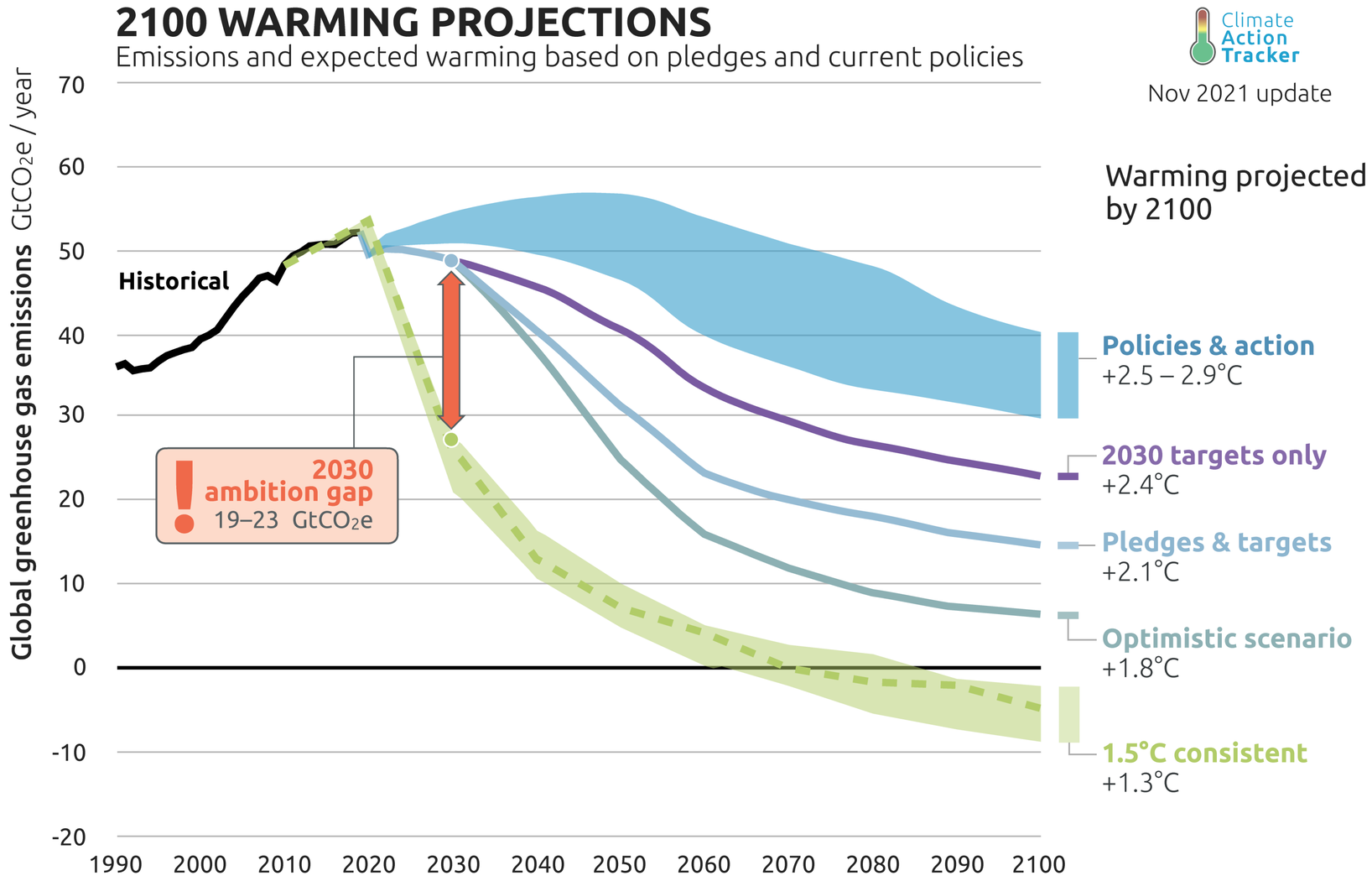
[Credit: NASA]

"Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

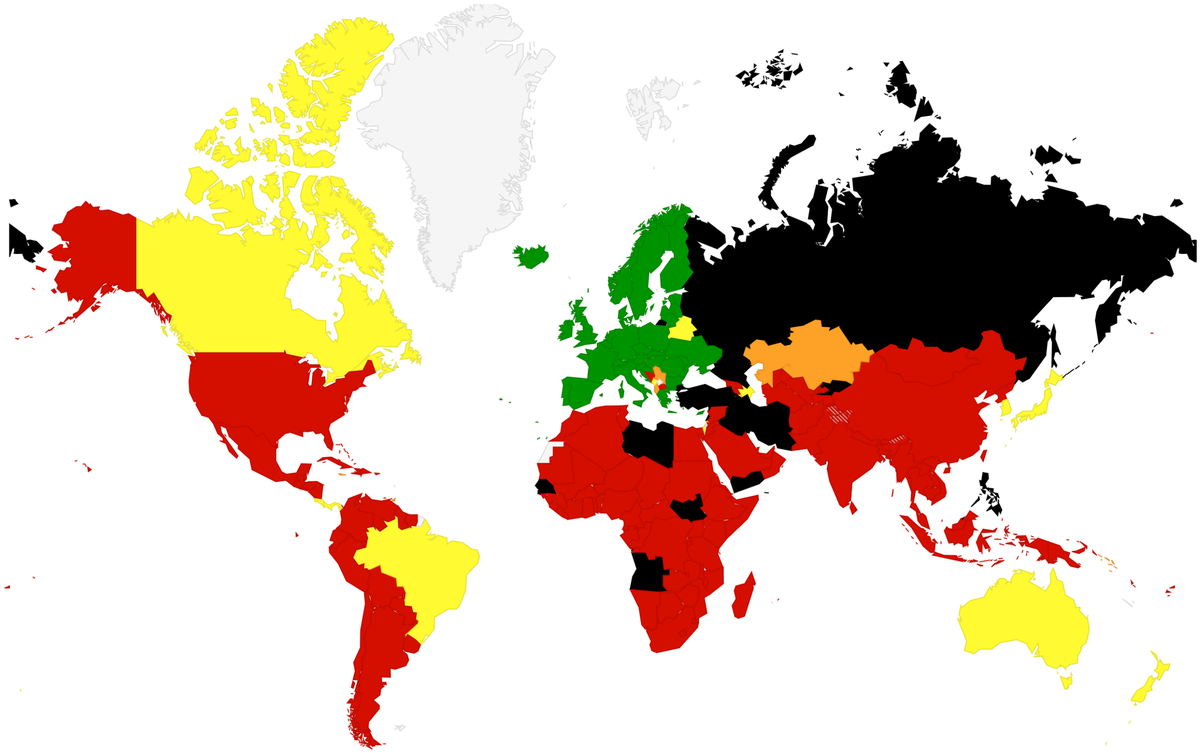
*Source: https://www.ipcc.ch*

# Climate Change Scenarios




*Source: https://climateactiontracker.org*

# Pledges Mostly Insufficient



**Sufficient**

Climate pledges **above or equal to 40%** emission reductions

**Partially Sufficient**

Climate pledges **between 20-40%** emission reductions

**Partially Insufficient**

Climate pledges below **20%** emission reductions and/or **up to 50% conditional**

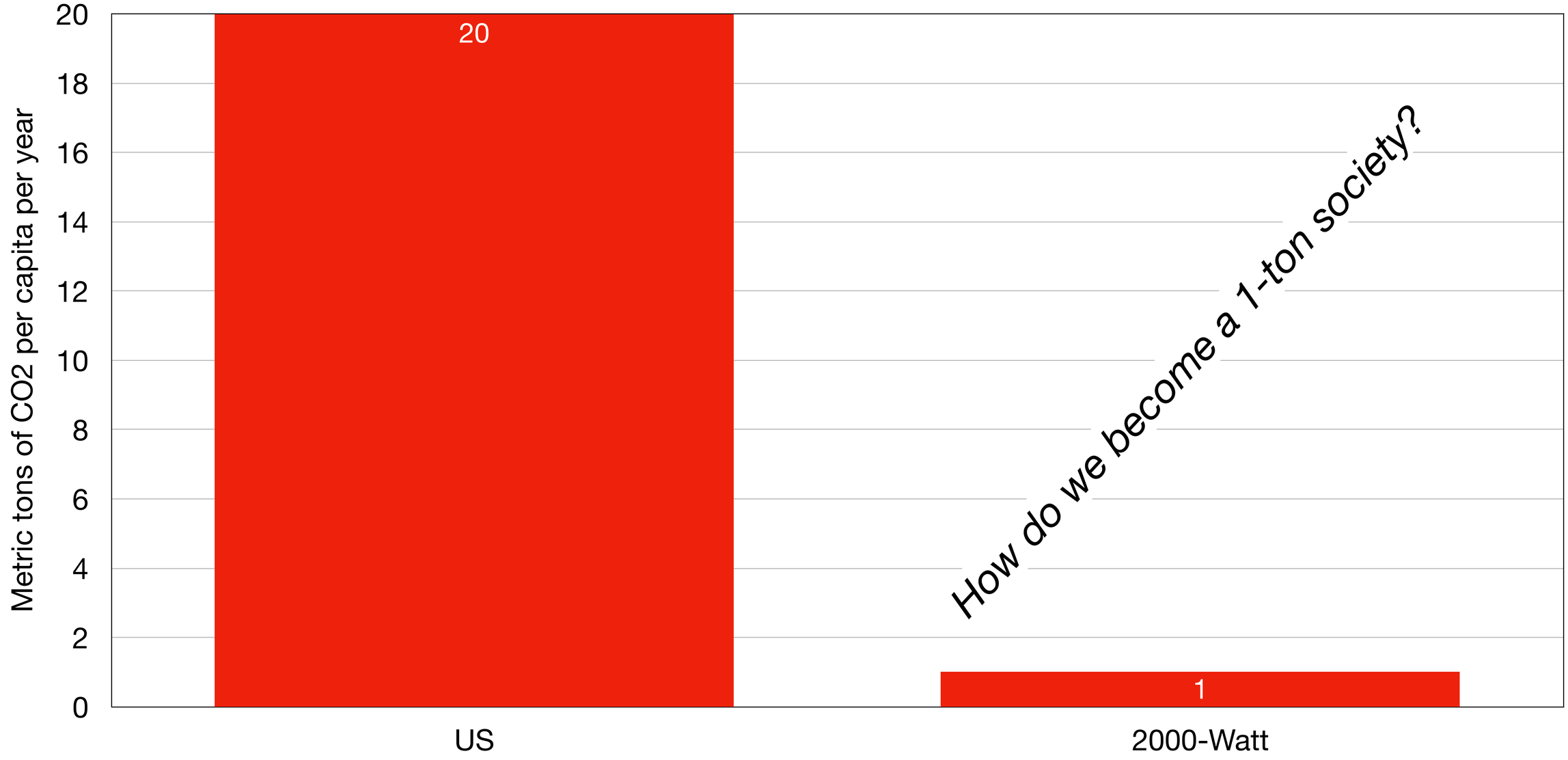
**Insufficient**

Climate pledges with **no emission reduction target,** more than **50% conditional**, with **intensity** target and/or **with Business as Usual (BAU) target**

**No pledges**

*Source: https://feu-us.org*

# US Climate “Olympics”



# Vision: 2000-Watt Society

A PROVEN PROCESS FOR
COURAGEOUS CLIMATE
LEAD

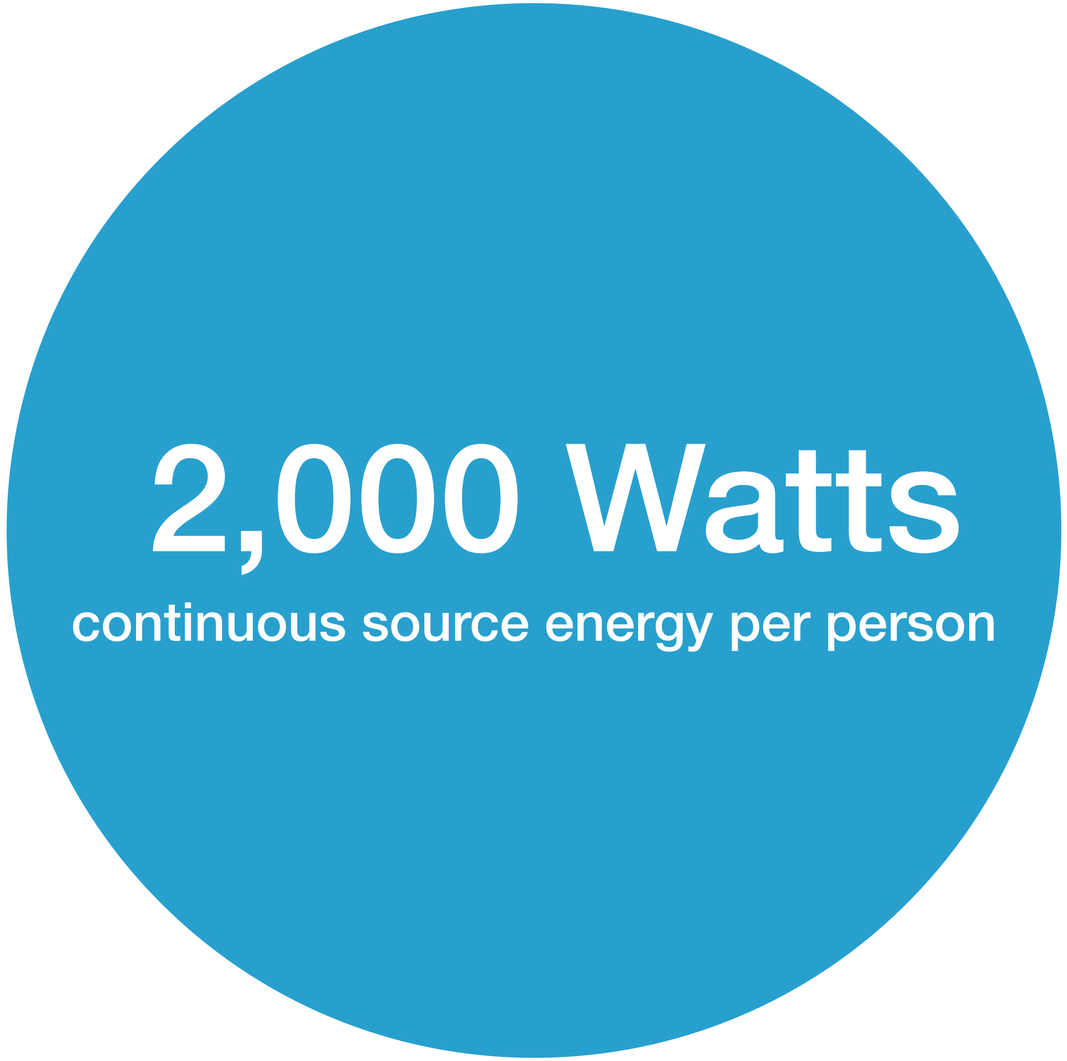
Make your city [illegible] 2000-watt society in the world.

[illegible] CLIMATE [illegible] NOW

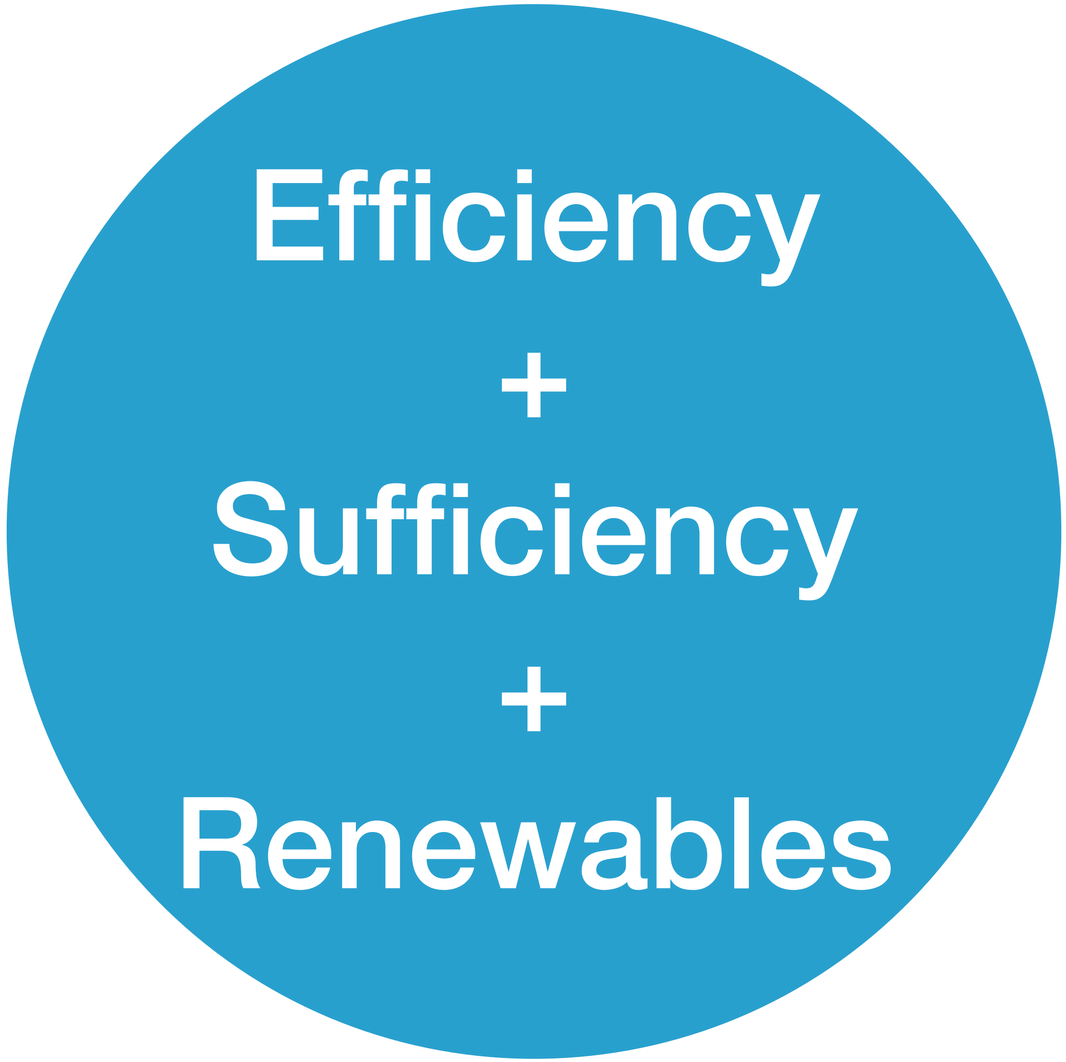
2000 watt SOCIETY

One target. Our community. Stepping up now.

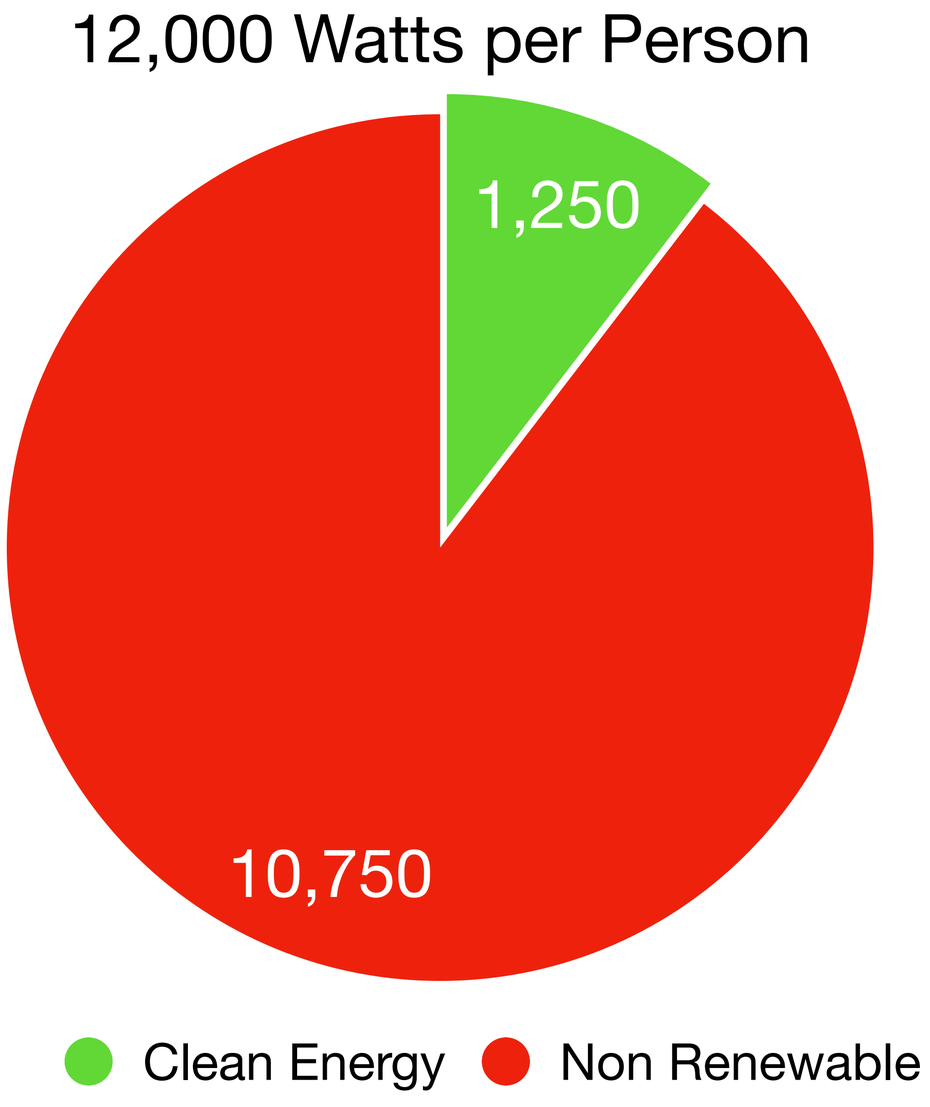
# One Target for All



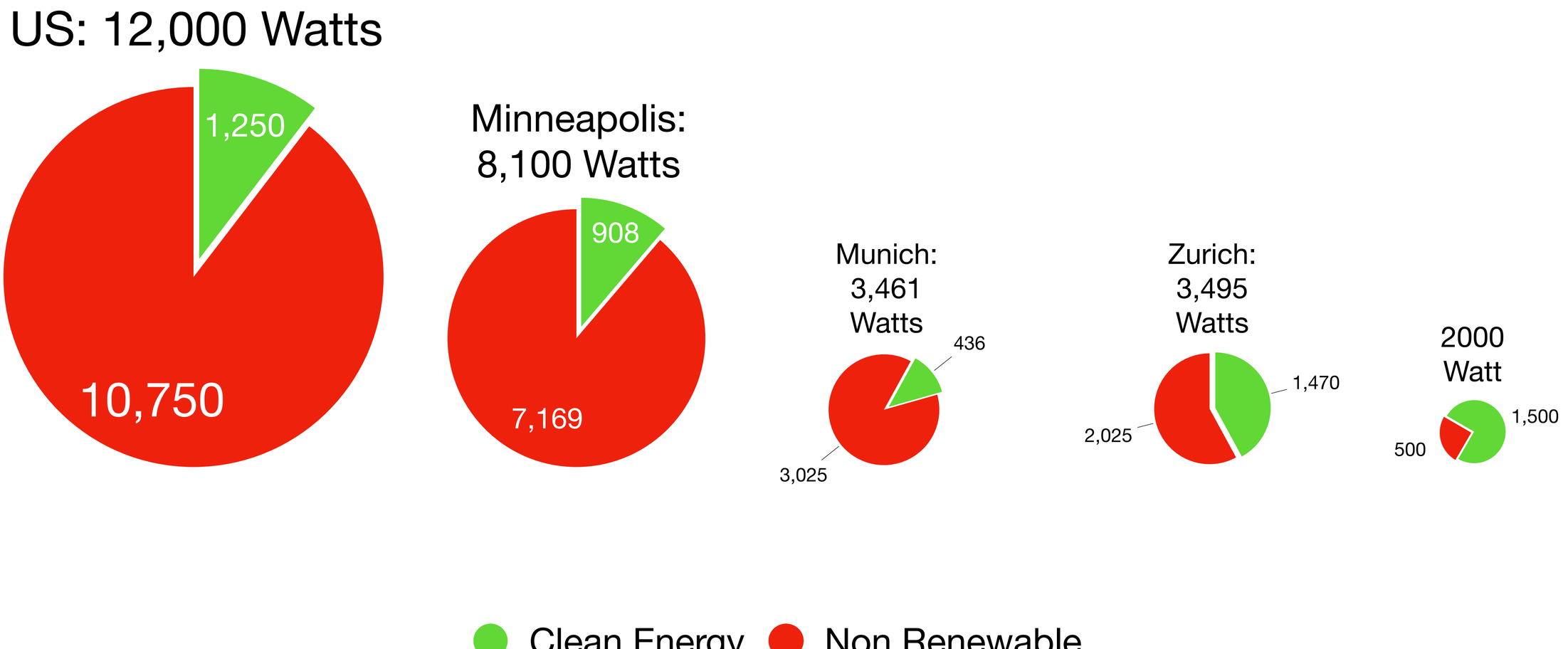
# One Strategy for All



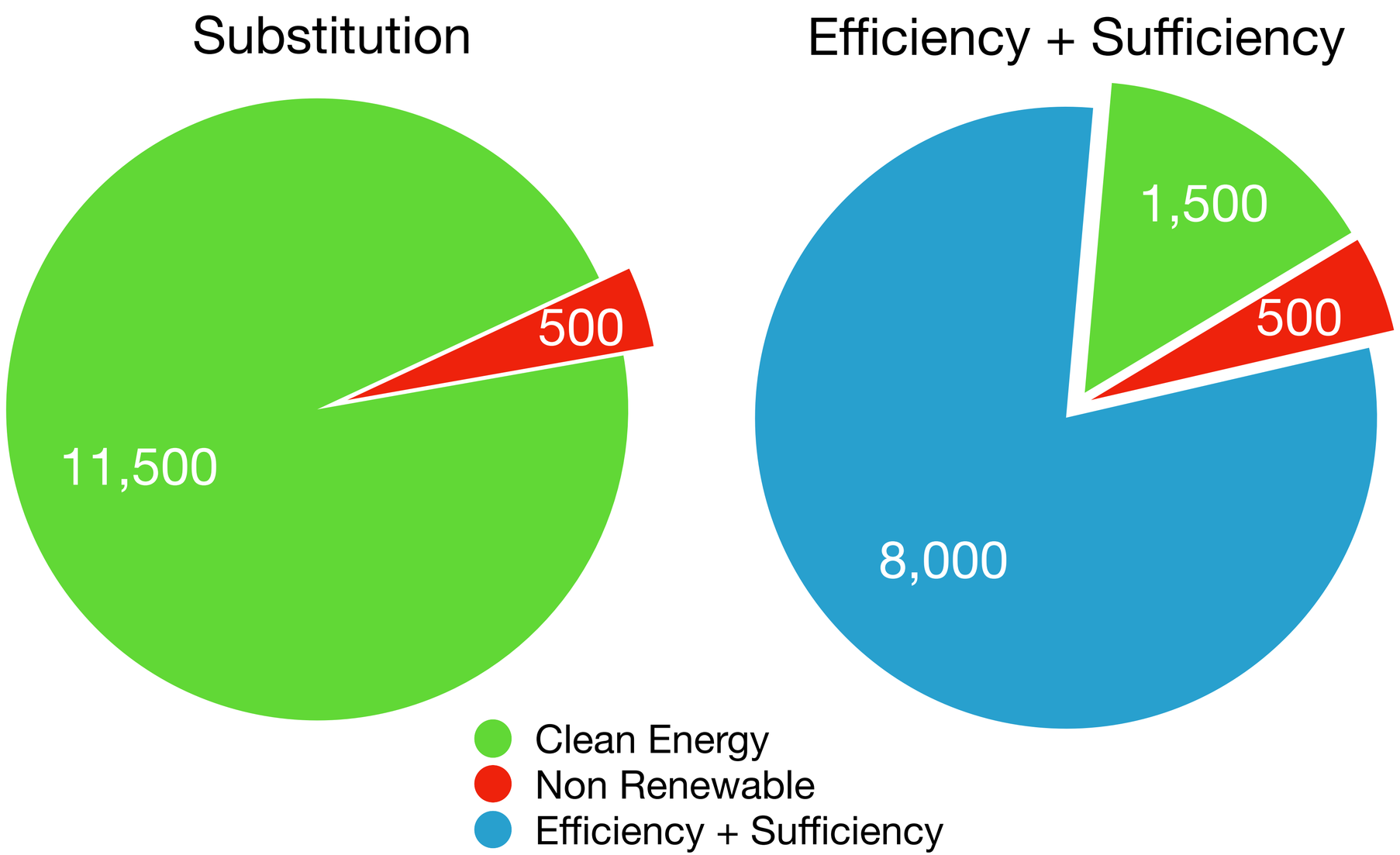
# The US Challenge



# Realities - Opportunities



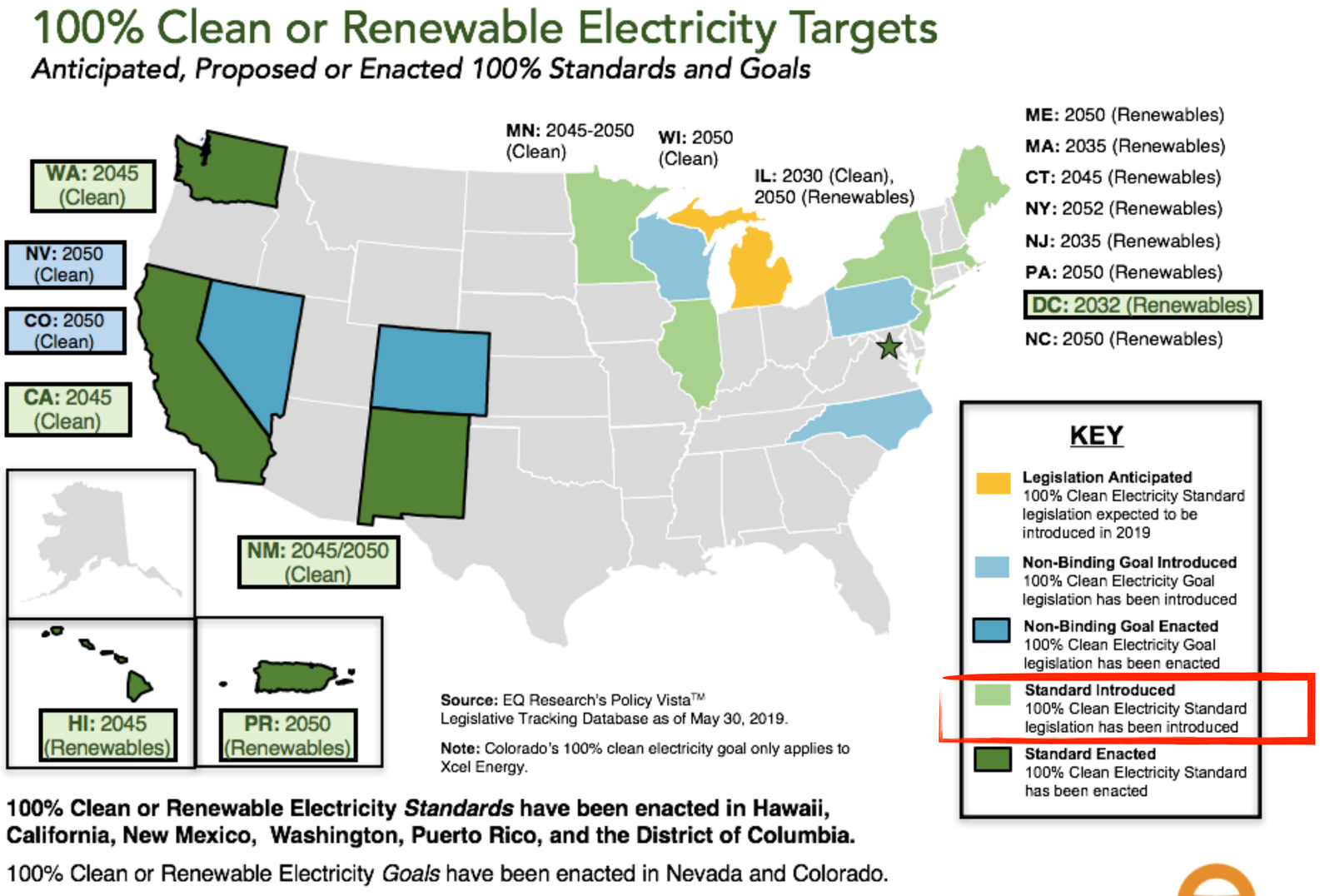
# Which Path Do We Invest In?



# Learning from Minneapolis

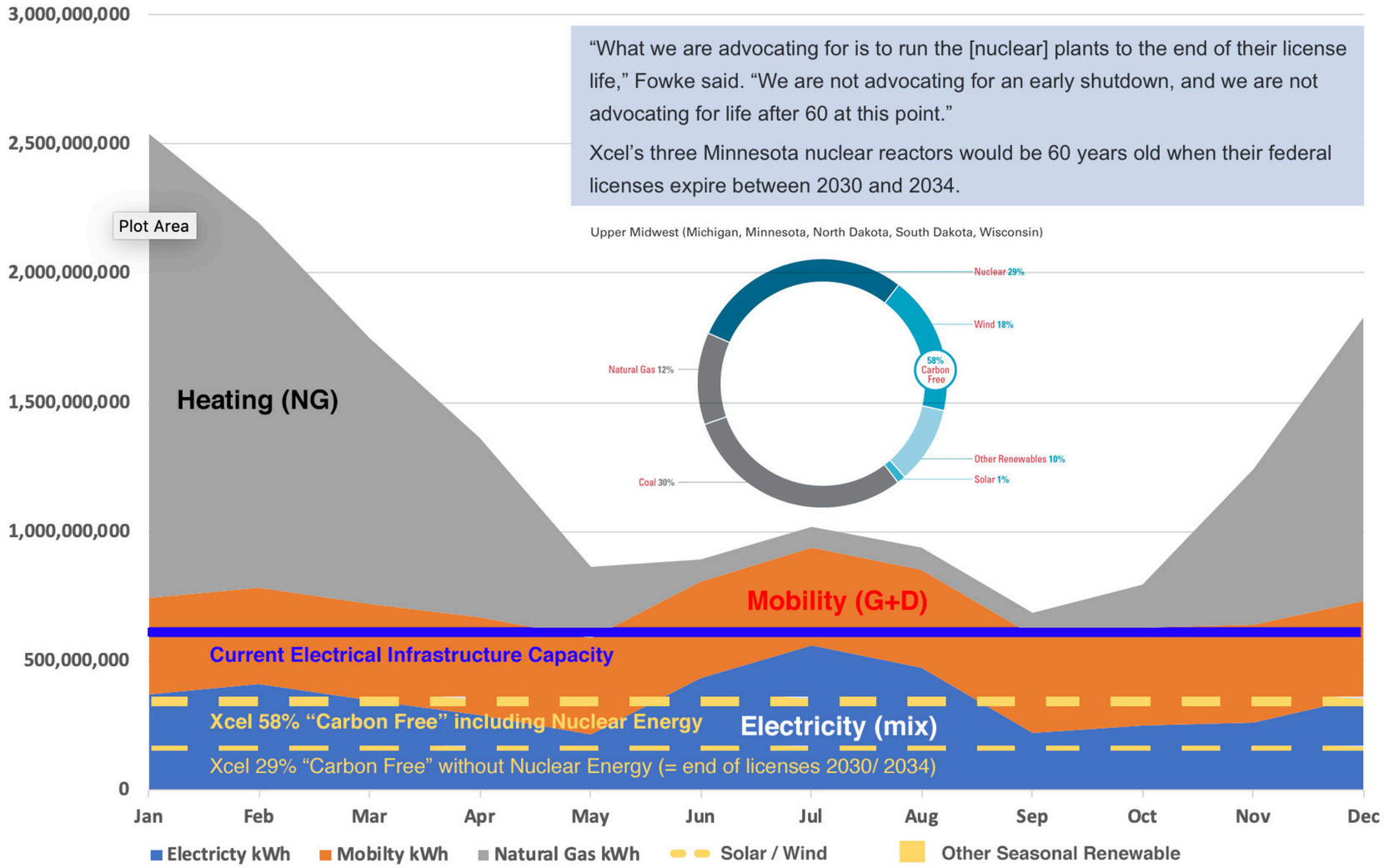
Substitution (“Electrify Everything”)

# Aspirations



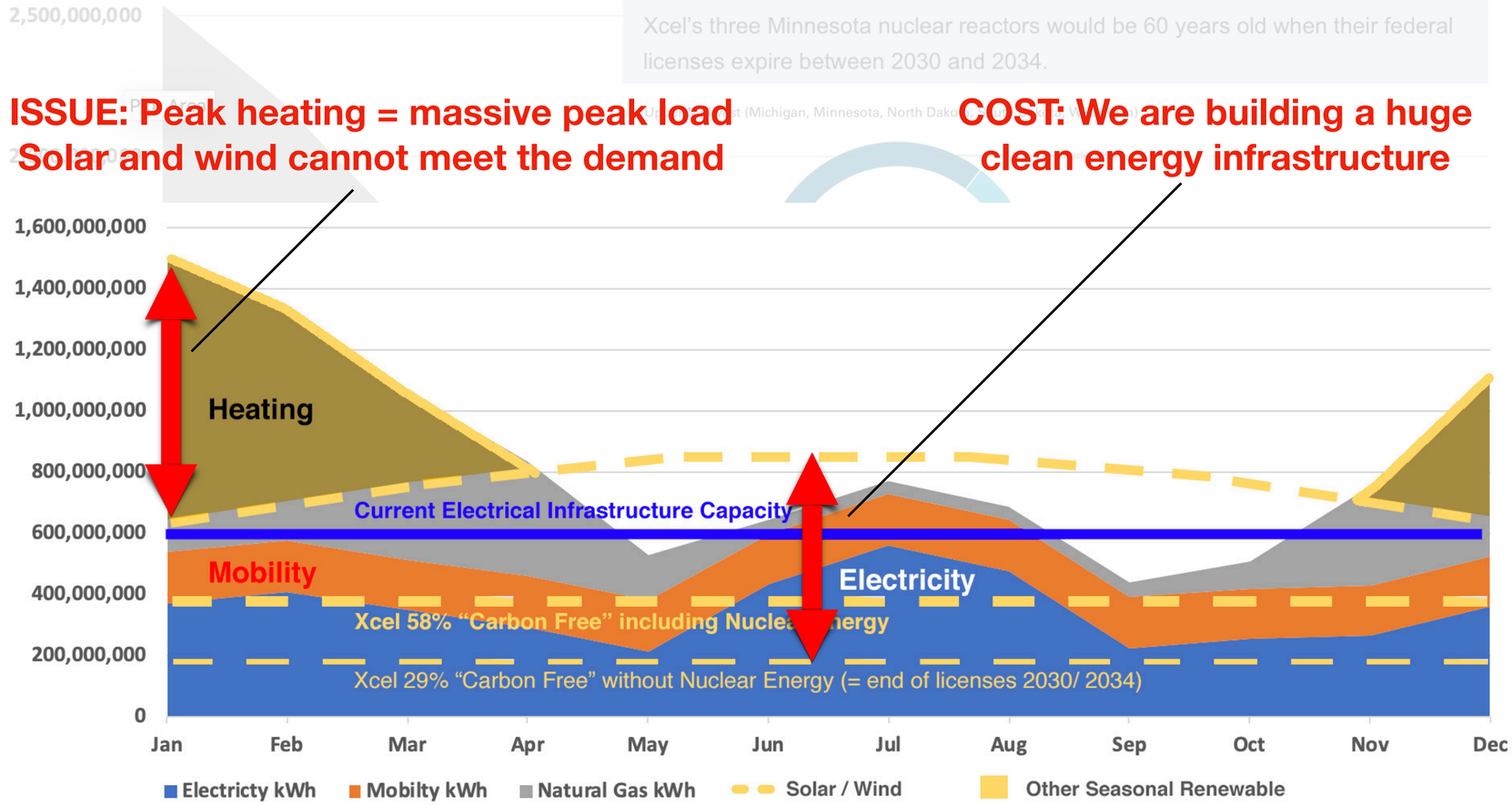

https://eq-research.com

# Current Energy Use



# Clean Energy Plan

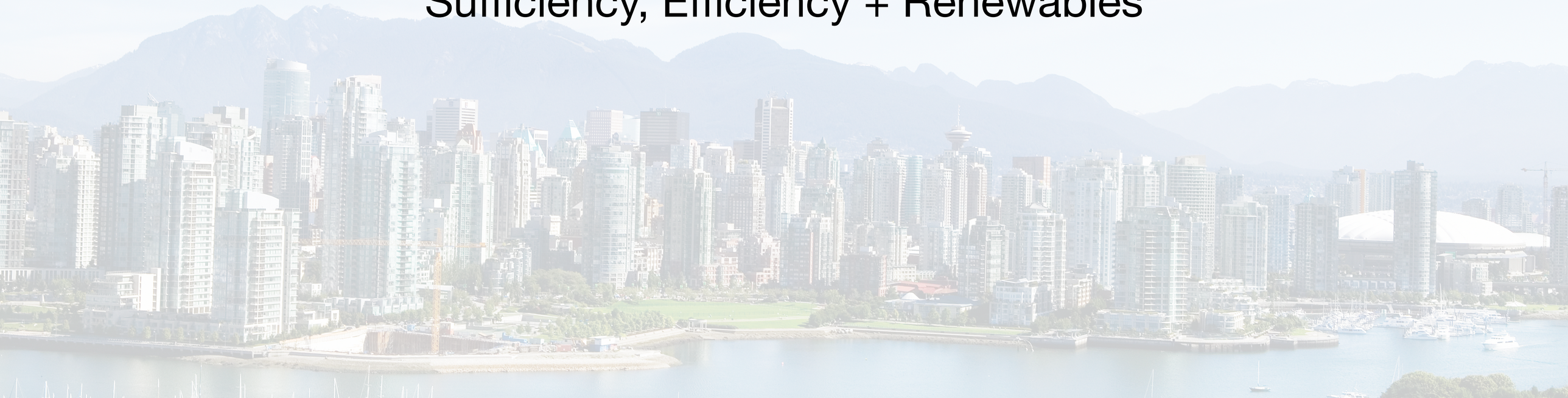
## Substitution: “Electrify Everything”




Hey, we have a massive
hill and valley problem!

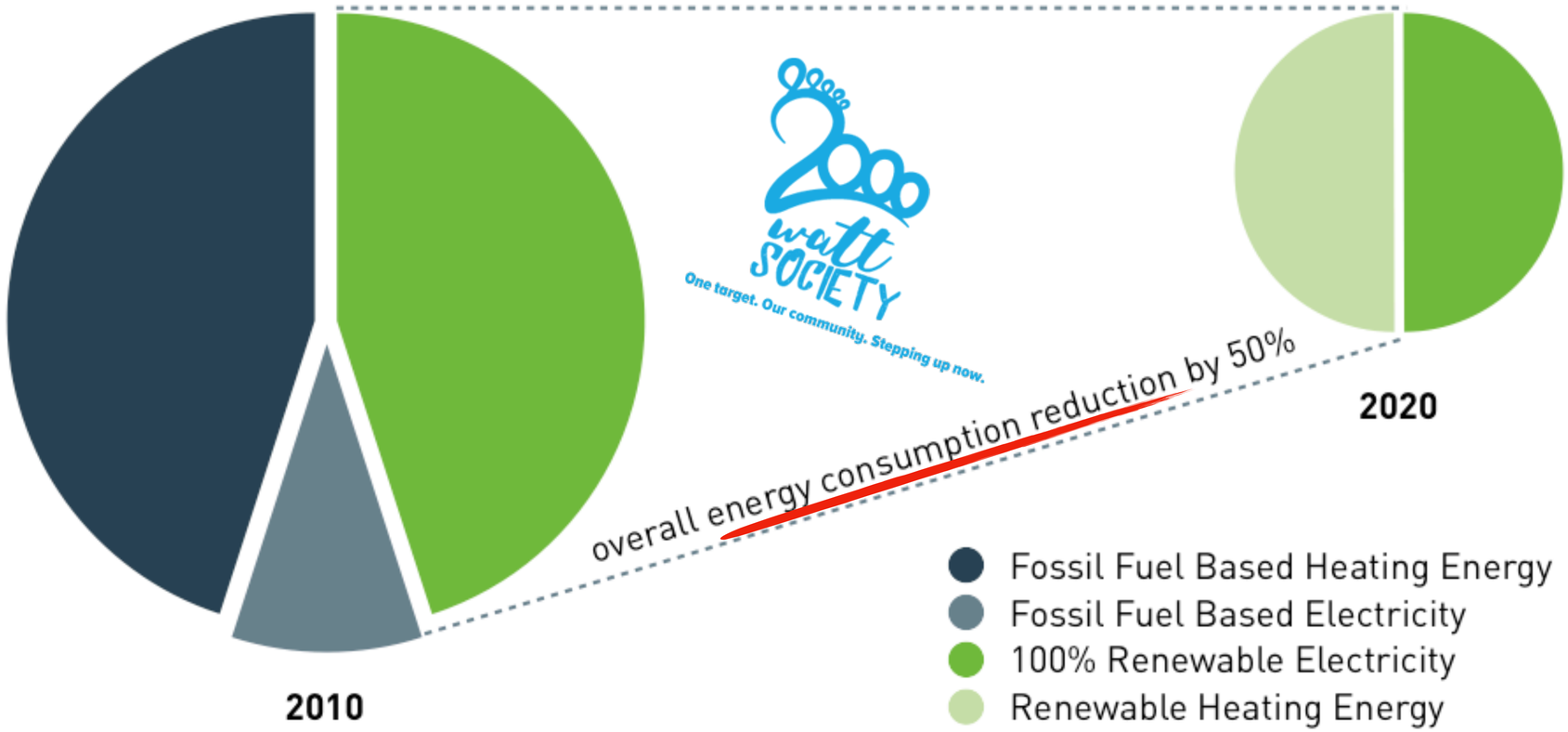
# Learning from Vancouver

Sufficiency, Efficiency + Renewables

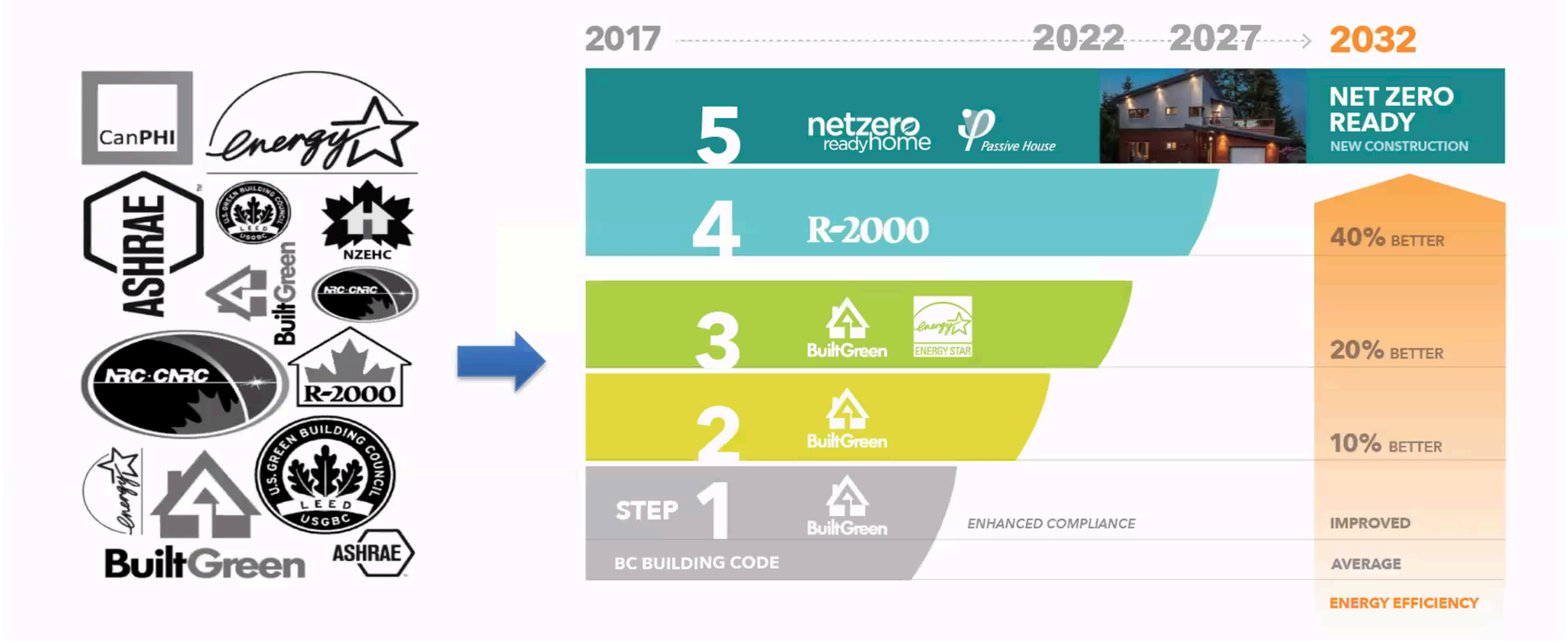


# Carbon Framework Plan

## “Efficiency+ Sufficiency + Renewables”



# Phasing In Efficiency



# With Passive House

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**Green Vancouver**

- Climate Emergency Action Plan
- Greenest City Action Plan
- Zero emissions buildings
  - Green home retrofit plan
  - Zoning amendments to support the Climate Emergency Response
  - High performance building standards
  - Building catalyst tools
  - Multi-family building energy resources and programs
- Zero Waste 2040
- Climate Change Adaptation Strategy
- Neighbourhood Energy Strategy
- How we are greening City operations

## High performance building standards

High performance buildings that meet Passive House and Net Zero Energy certified standards are recognized as pathways to meet Vancouver Building By-law energy requirements, rezoning conditions, and also serve as applicable standards to qualify for a number of discretionary zoning variances.

### Catalyst tools

To support innovation and design to high performance building standards, catalyst tools such as additional floor area allowances are available for multi-unit residential projects.

Find out more about catalyst tools

# Energy Flow

Understanding Opportunities and Challenges,
and the sustainable future of Buildings.

# Source

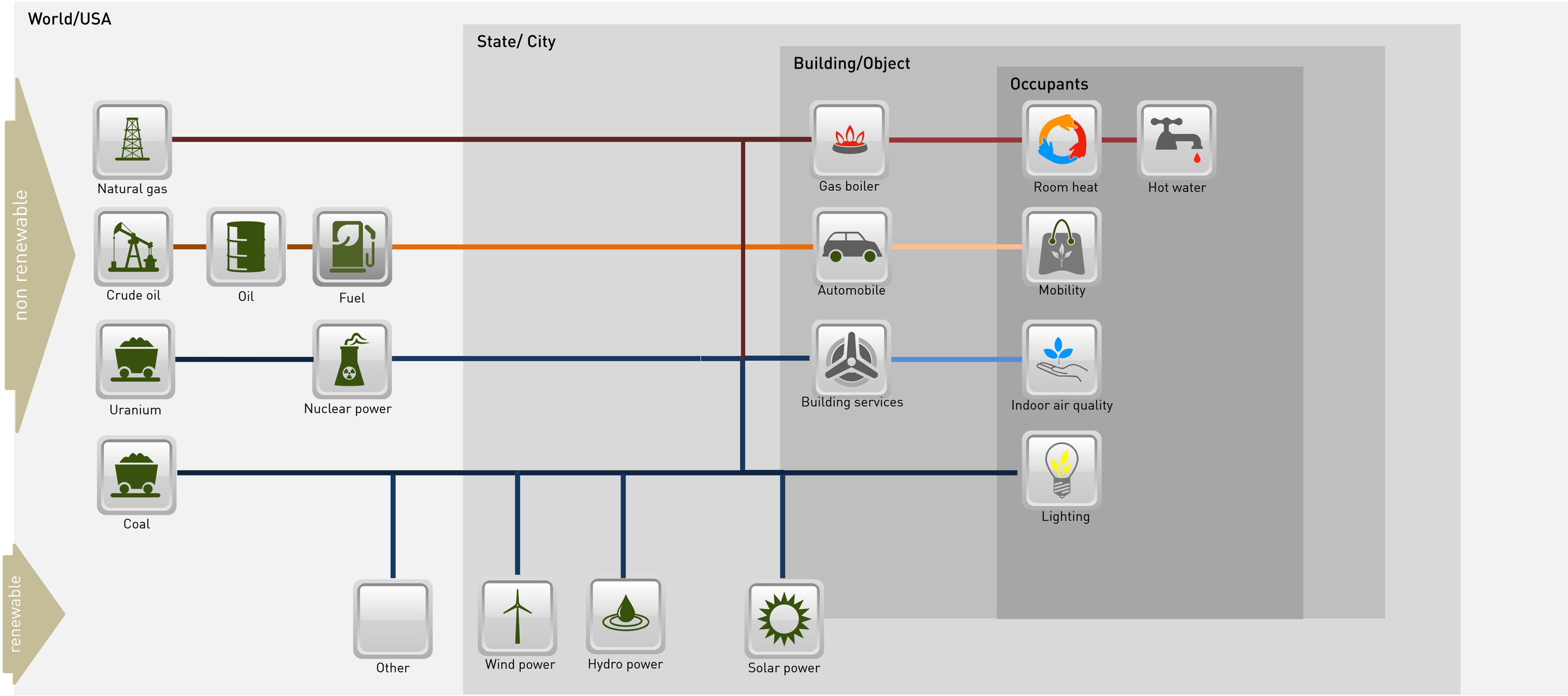
**We extract and pollute, or harvest here…**

# Site

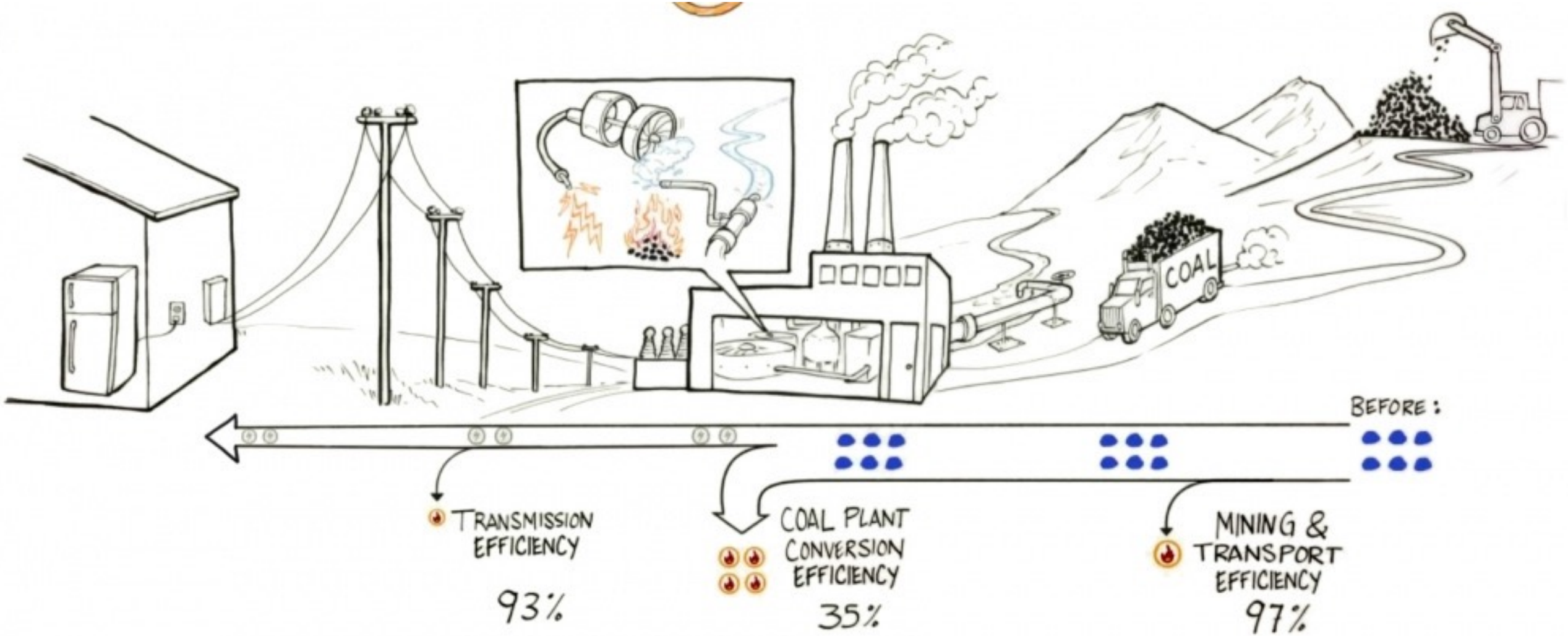
**…and pay here…**

# Useful Energy

**…to satisfy our needs.**



# Inefficiencies



# Compounding Losses

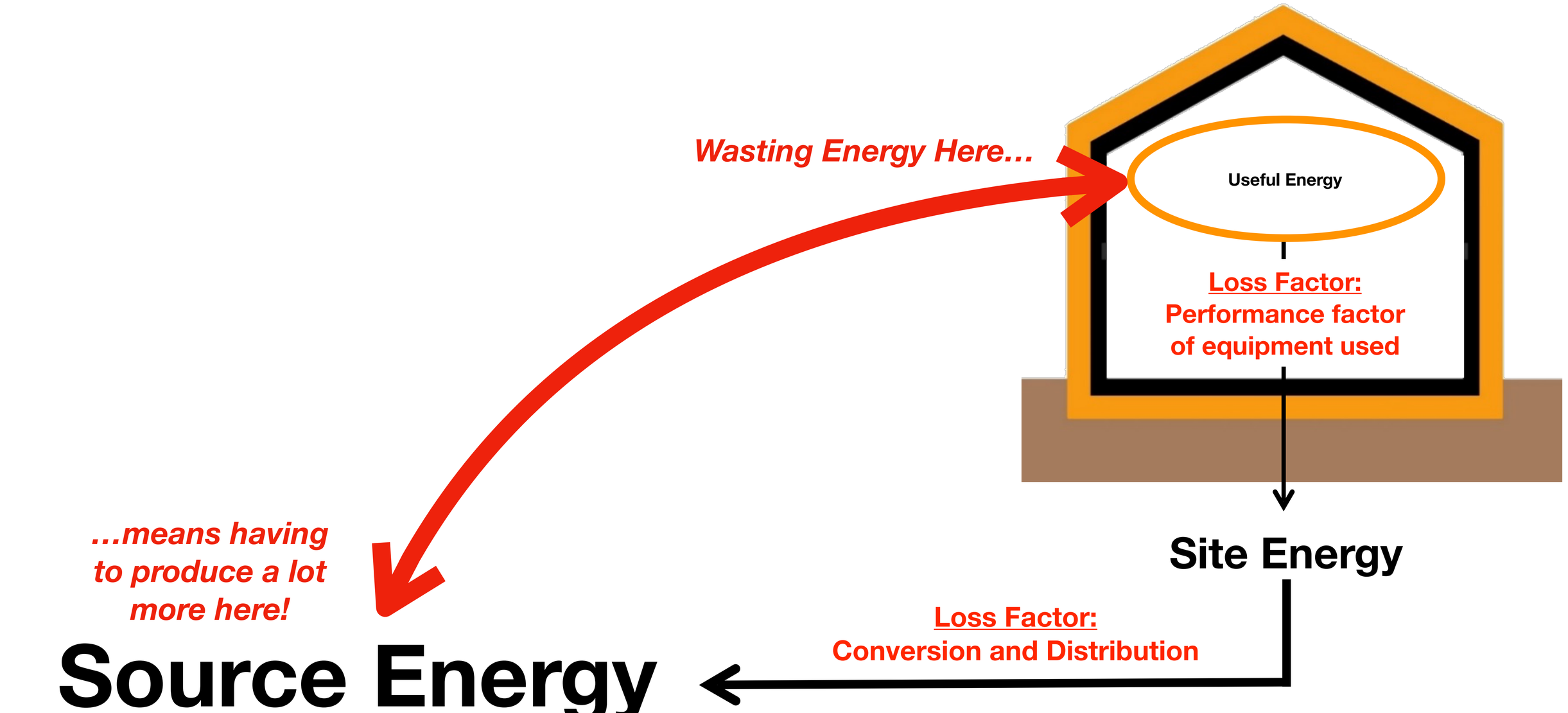



Illustration: PHD & PHI

# Multiplying Savings

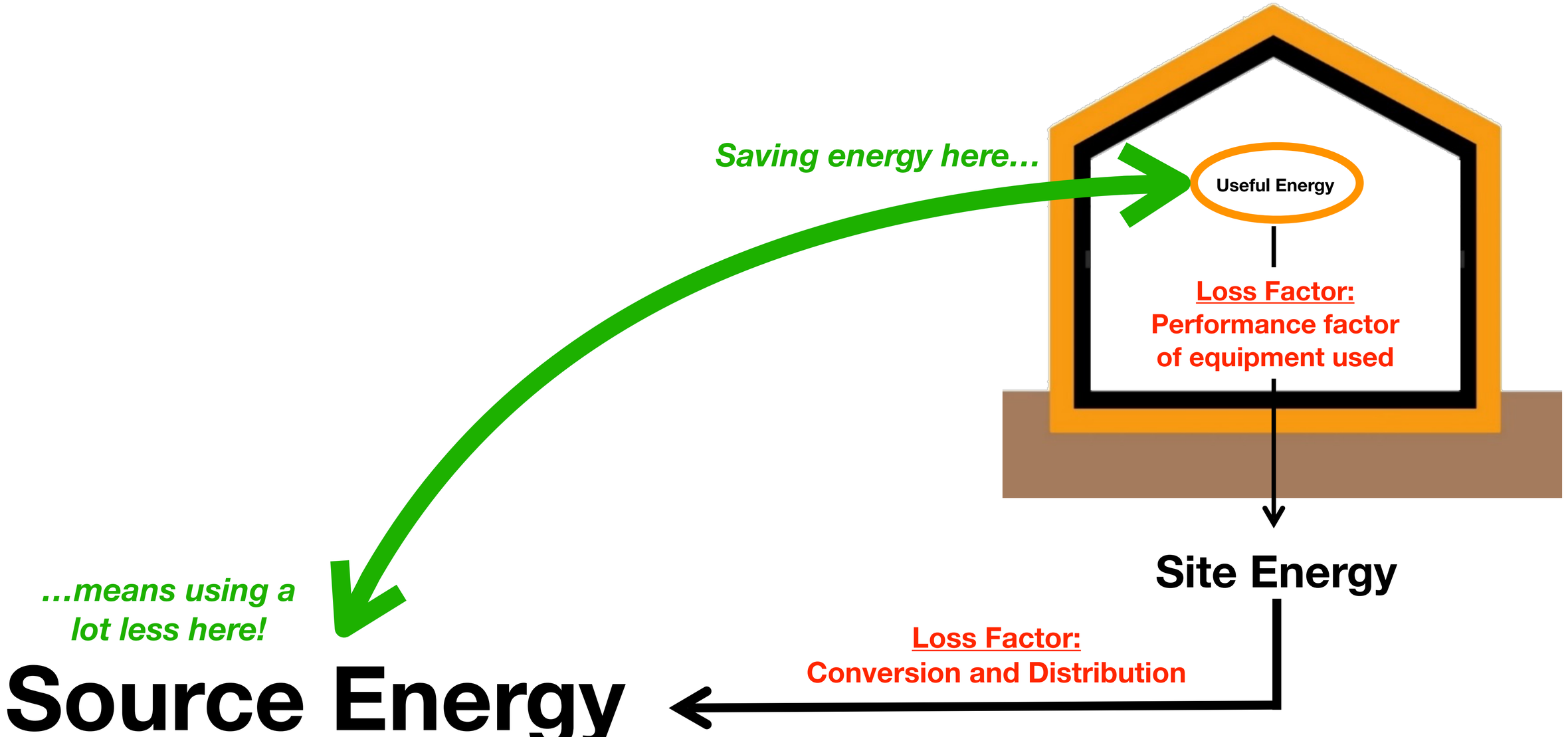


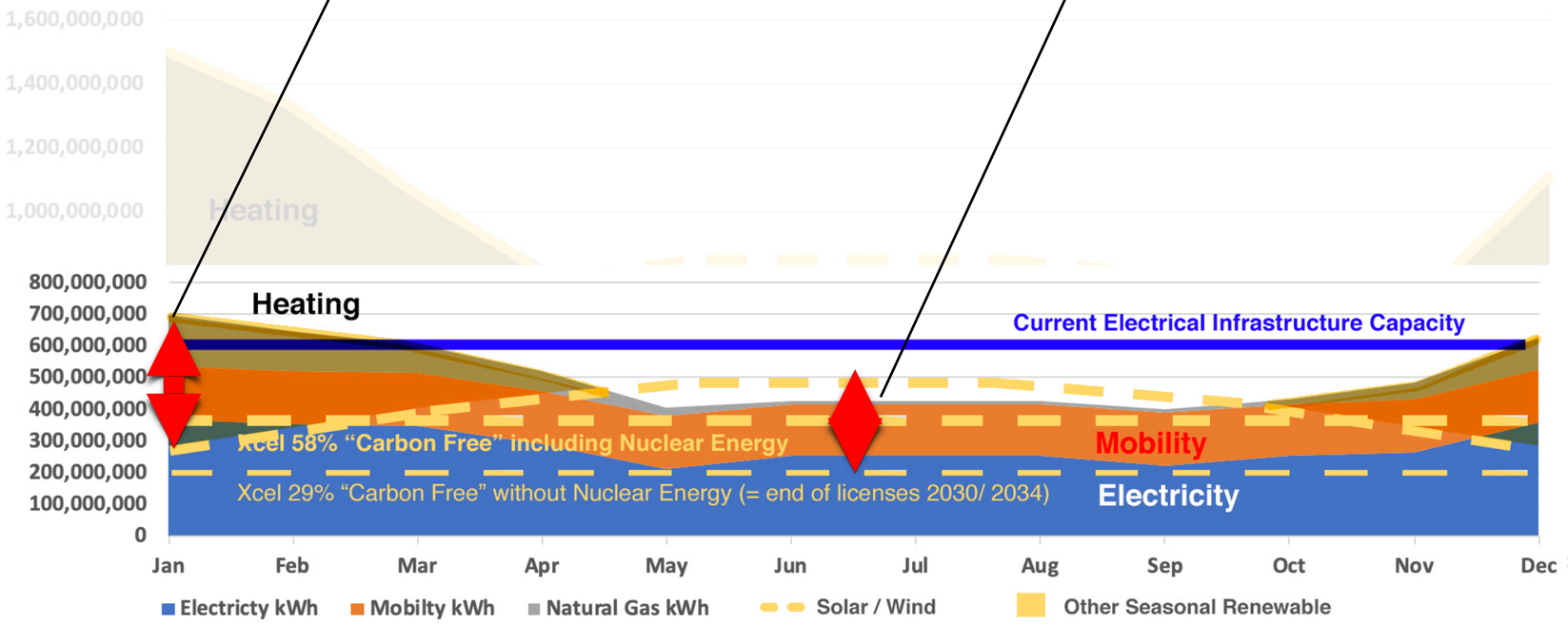

Illustration: PHD & PHI

# Better Clean Energy Plan

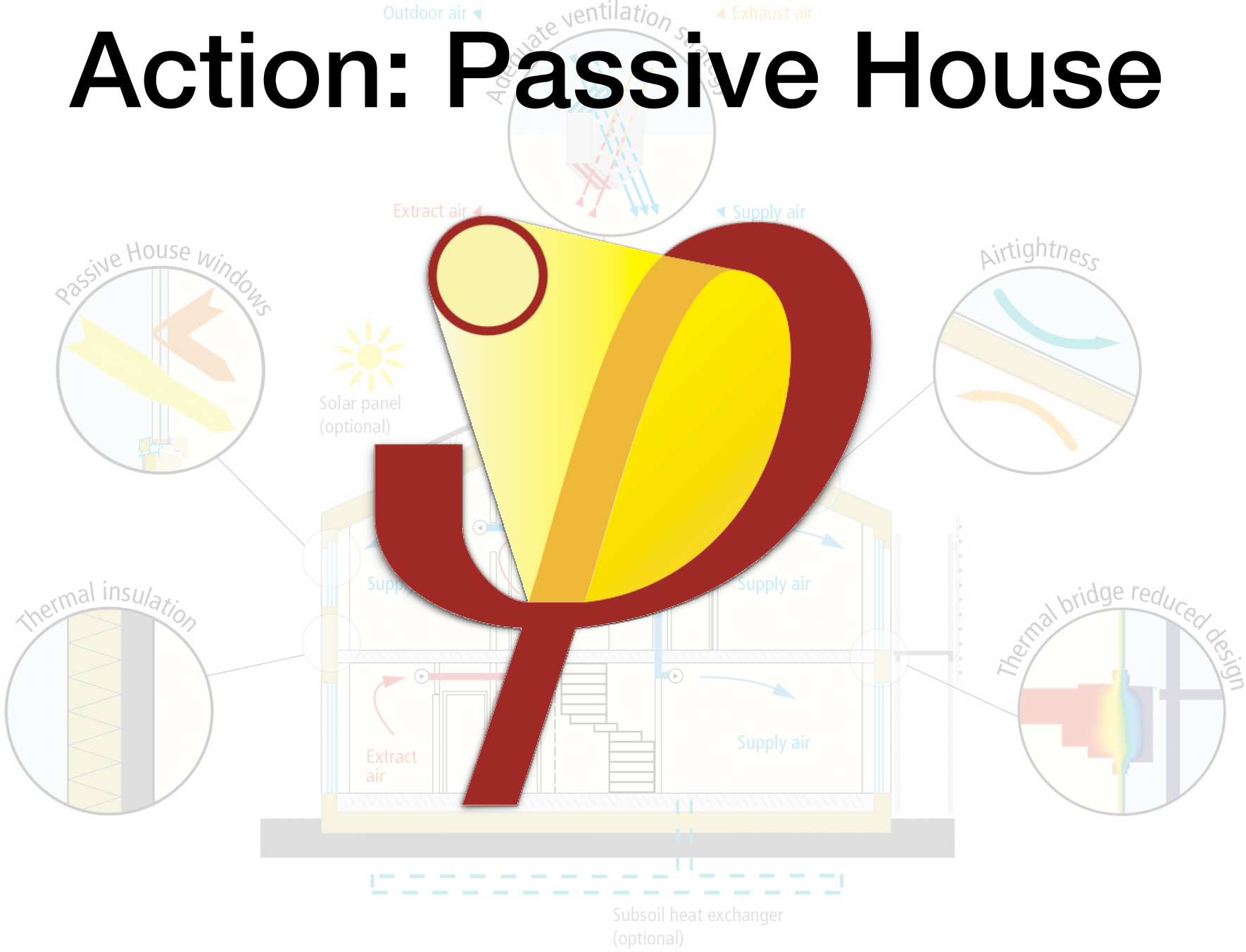
## Efficiency First: “Retrofits + Efficiency”

**SOLUTION: Massive peak heat load reduction reduces supply and load shifting issues!**

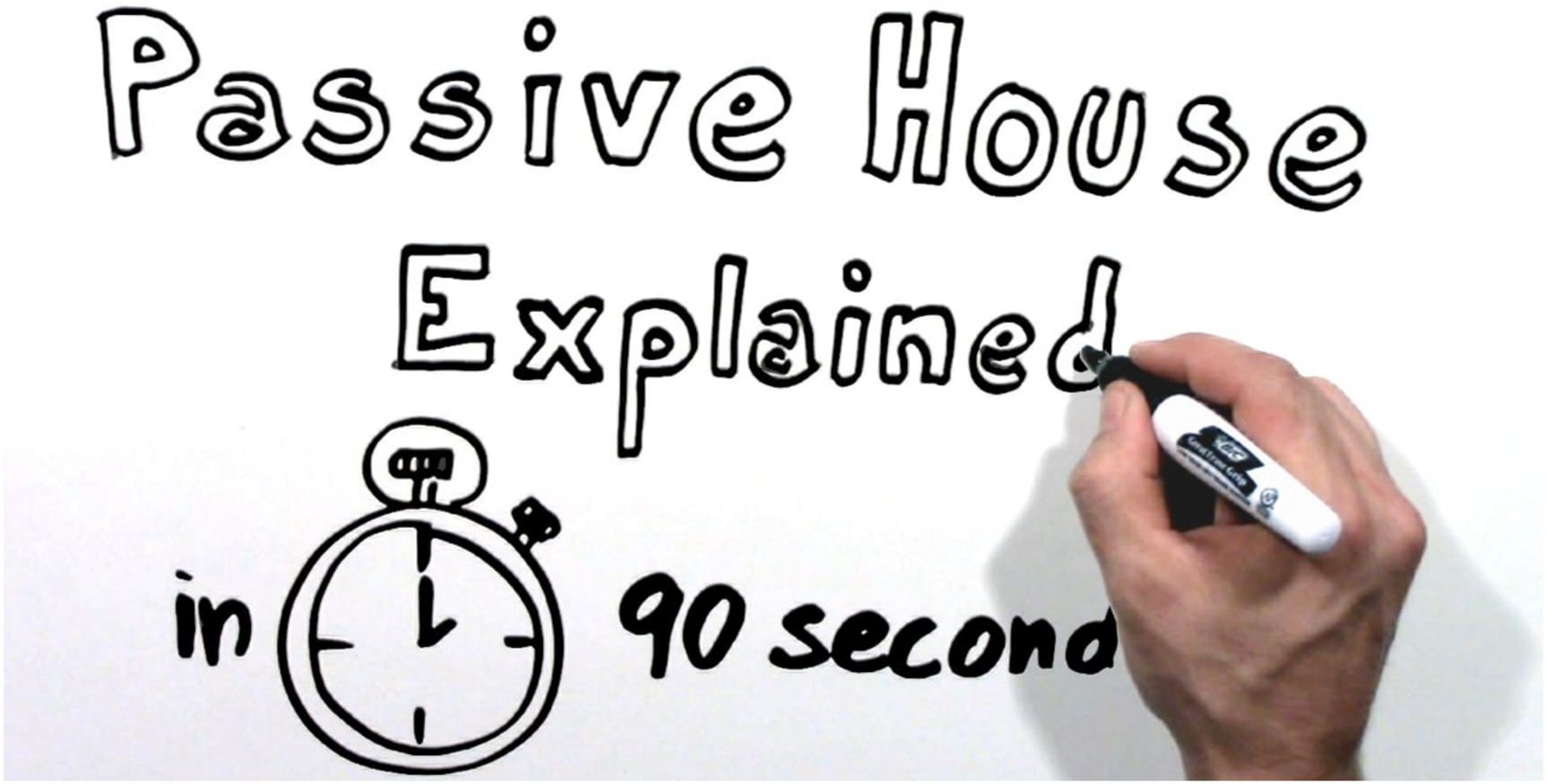
**COST: We are building a small clean energy infrastructure**



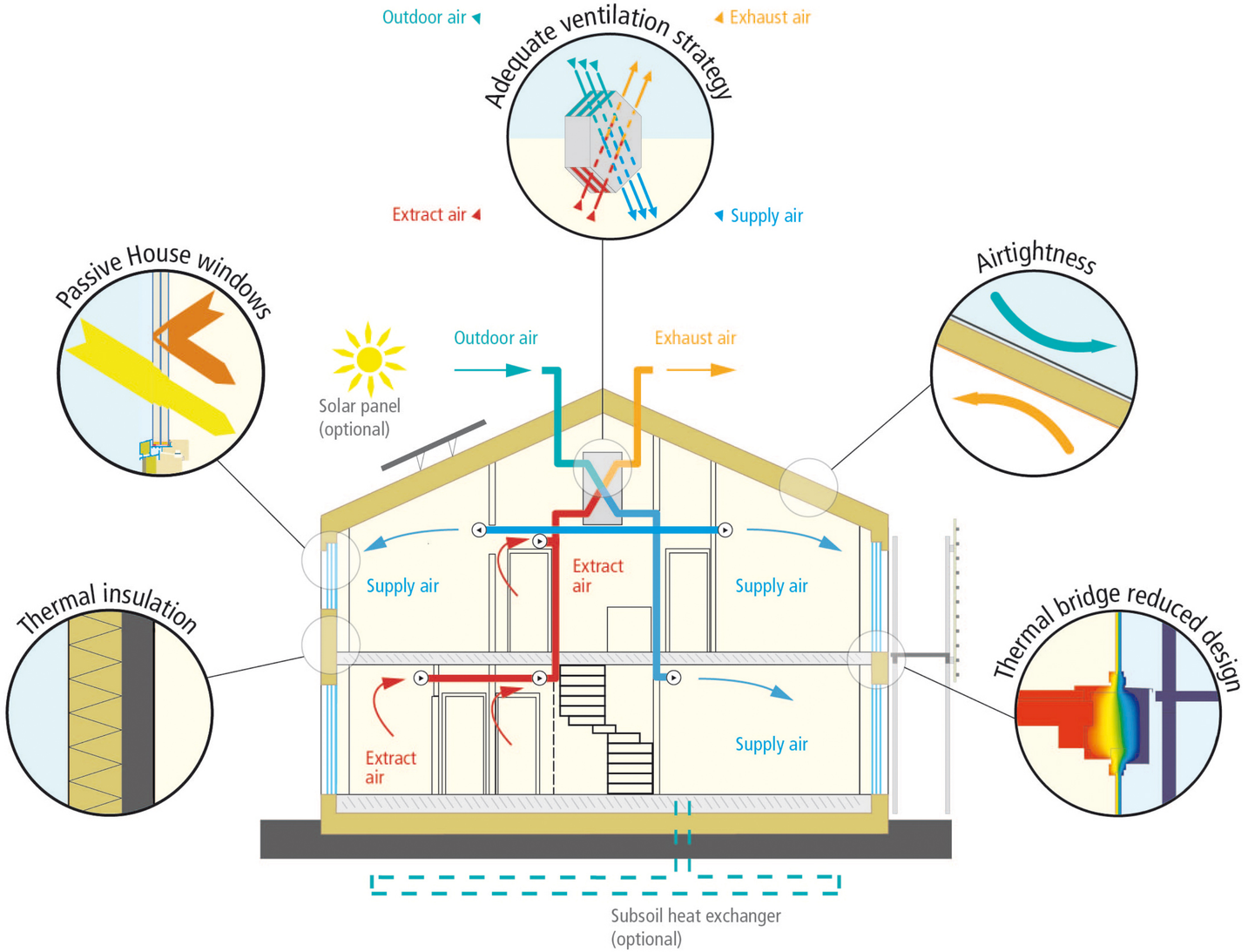
# Action: Passive House



# Passive House



# 5 Basic Science Principles



# Paradigm Shift

# Passive House…

- Defines the long-term building quality and performance independent of energy supply.
- Reduces the amount of Useful Energy needed to operate the building significantly.

# Benefits Multiplied

## Energy Efficiency

= Climate Impact Reduction

= Human Comfort and Health

= Resiliency

= Durability

= Life Cycle Cost Efficiency

= Social Justice

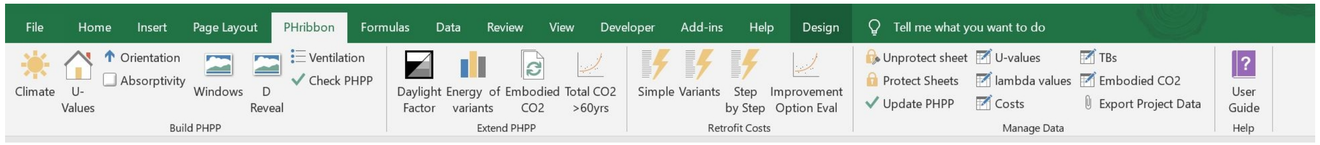
# Beneficial Electrification

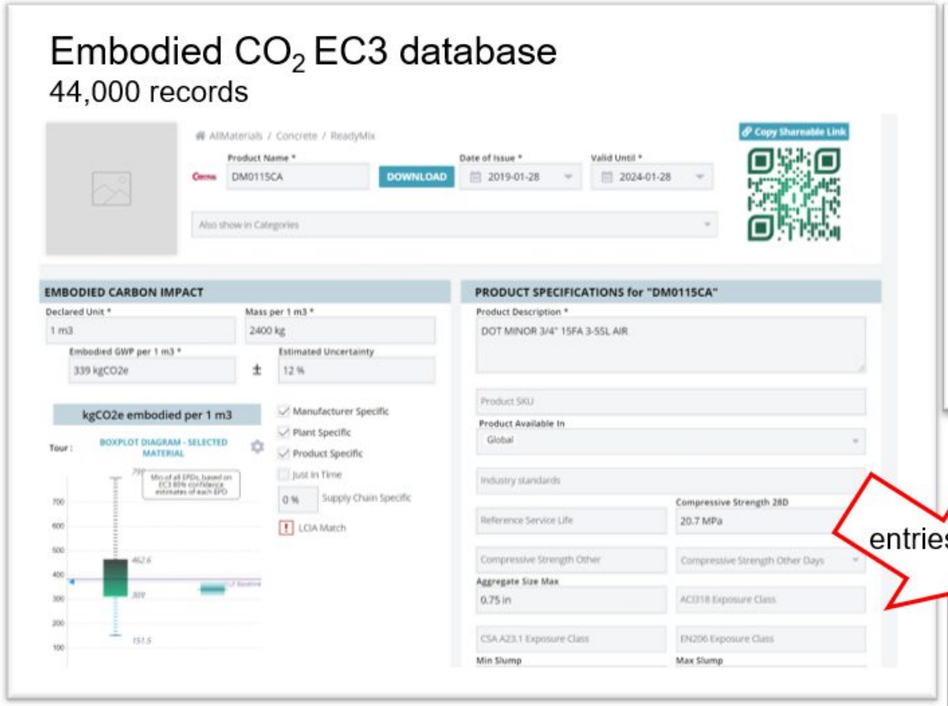

Resource: https://rmi.org/insight/decarbonizing-homes/

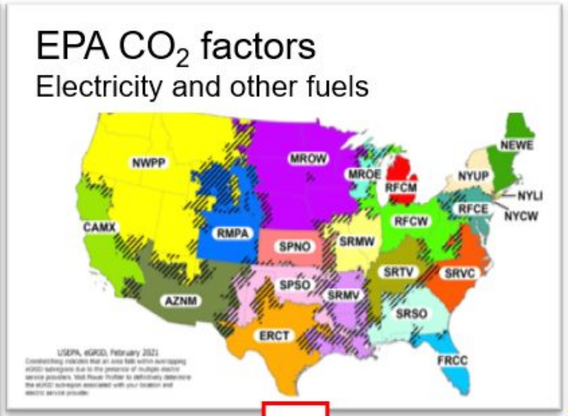
# Beneficial Electrification with Passive House

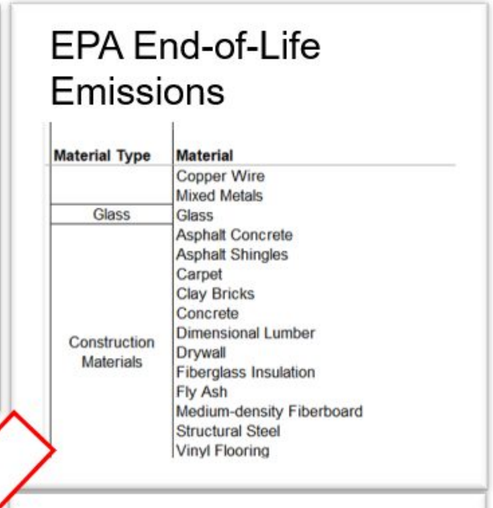
- Of course, we recognize the implications of an **integrated whole systems approach** – it's called Passive House and the report doesn't shrink from this implication but instead specifically calls out **the Passive House methodology as a core strategy of beneficial electrification**.
- The formula Passive House + Electrification + Renewables is a simple expression of the integration proposed by beneficial electrification.
- The report does a great job of laying out further positive results too: fewer toxins, less pollution, less asthma, allergies, protection from weather extremes, grid resilience, and increased safety for neighborhoods and communities – in particular helping close the gap in health outcomes for low-income communities.

# And Embodied Energy



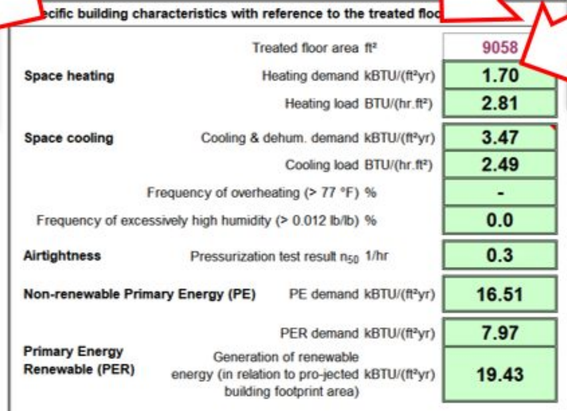




entries

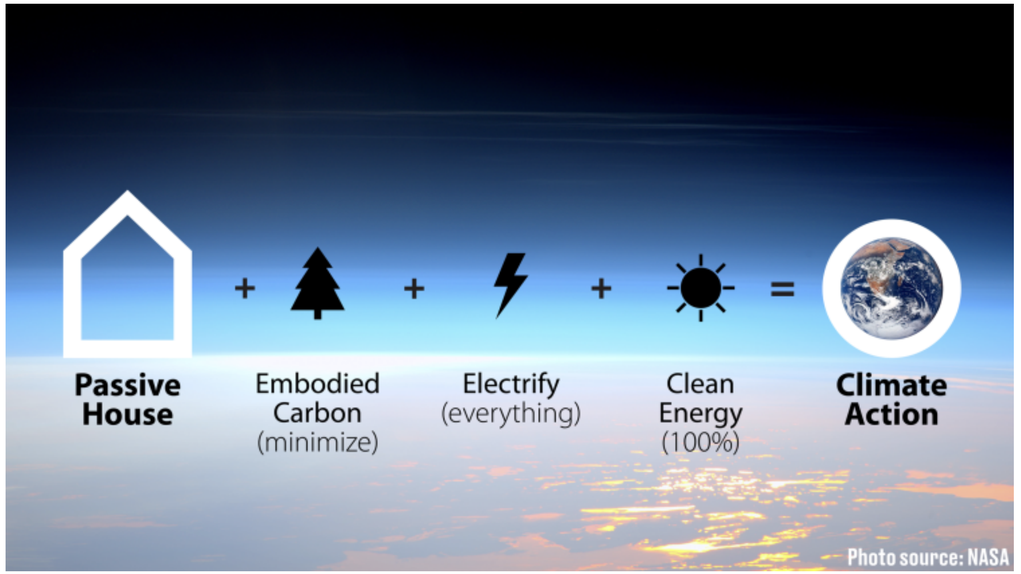
PHPP




End of Life pathway
% Recycling
% Combustion
% Landfill

**PH Ribbon**

# = Foundation for Climate Action

# Passive House + Renewable Energy

- Passive House is a solar thermal collector and a battery
- Passive House Plus and Premium add an active renewable energy component towards climate-neutrality
- Passive House energy efficiency enables the effective use of renewable energy sources
- #EfficiencyFirst = peak loads in a PH are hugely reduced (in particular the Carbon-laden heating loads)
- Building energy efficiency and reduced peak loads keep a lid on the scale, scope and cost of the clean grid
- Optimizing the system as a whole (demand and supply) offers a powerful approach. However, challenges such as the need for seasonal energy storage remain but are much smaller.


Remember Me?

# PER
# The assessment for a sustainable energy supply

- PER (Primary Energy Renewable) provides an appropriate measure of how much energy needs to be generated sustainably from renewable energy sources in order to provide a given amount of energy to the end user.

- PER thus shows just how efficient different application technologies are in the context of a sustainable renewable energy supply.

# The PER Approach

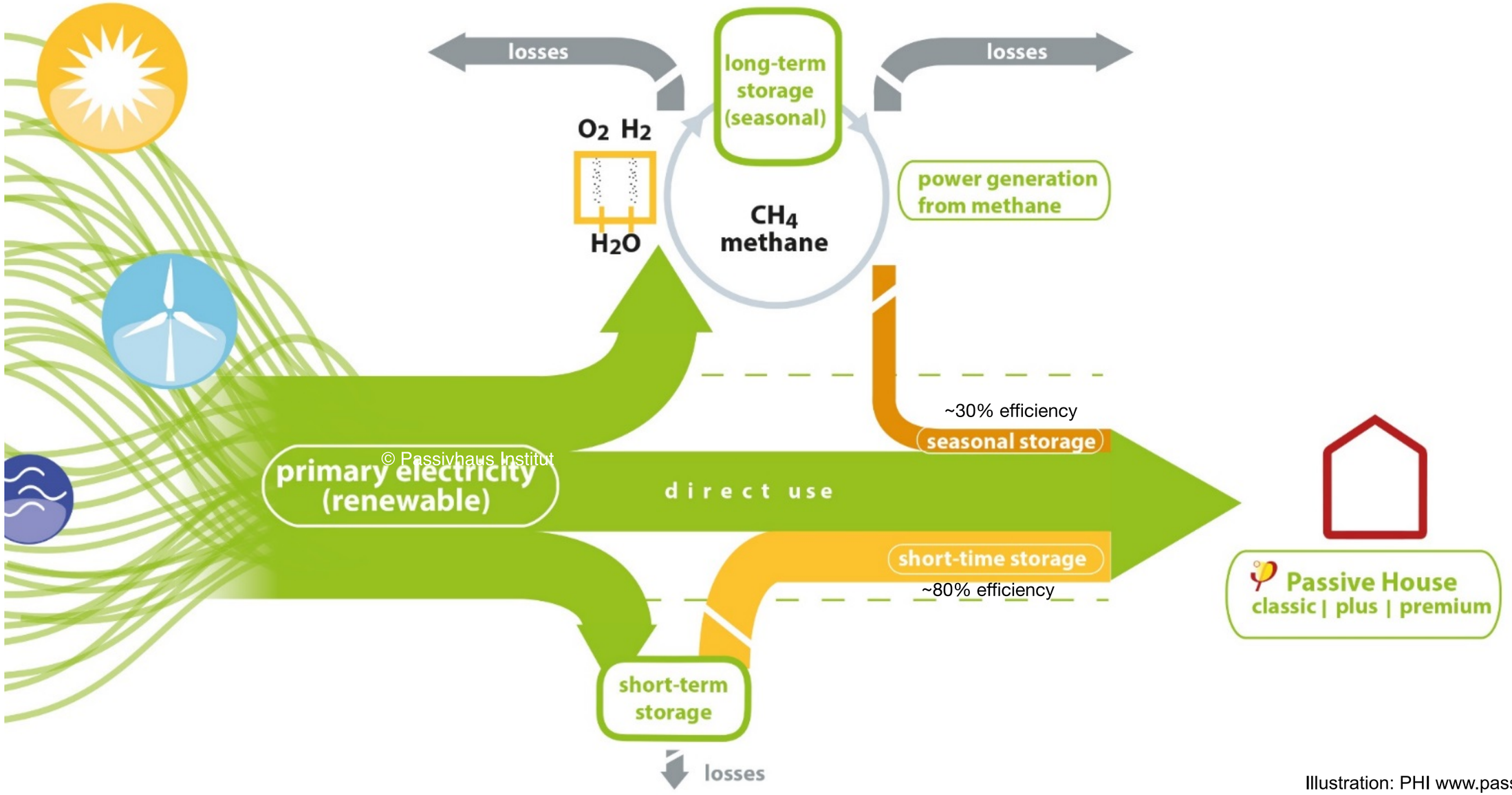
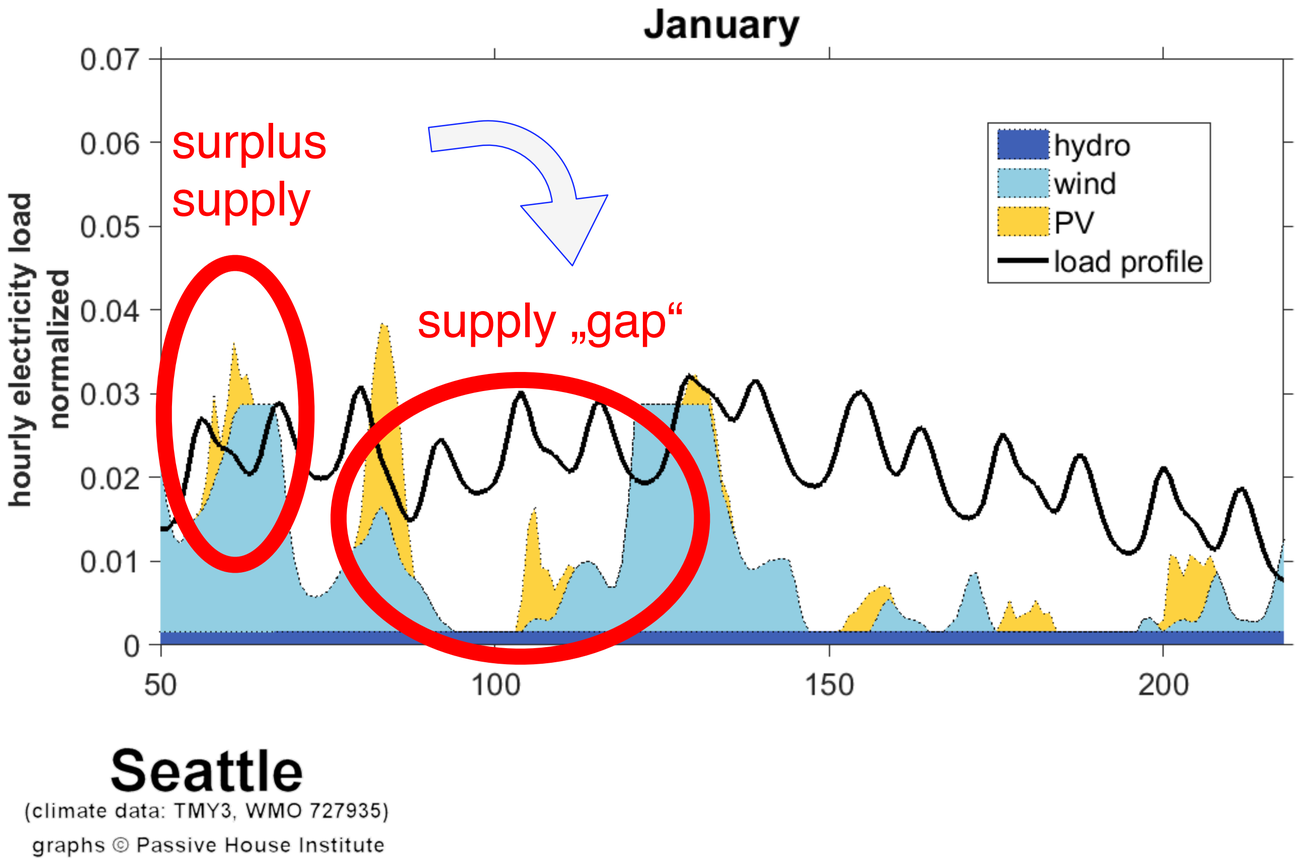



Illustration: PHI www.passipedia.de

# Renewables in Winter

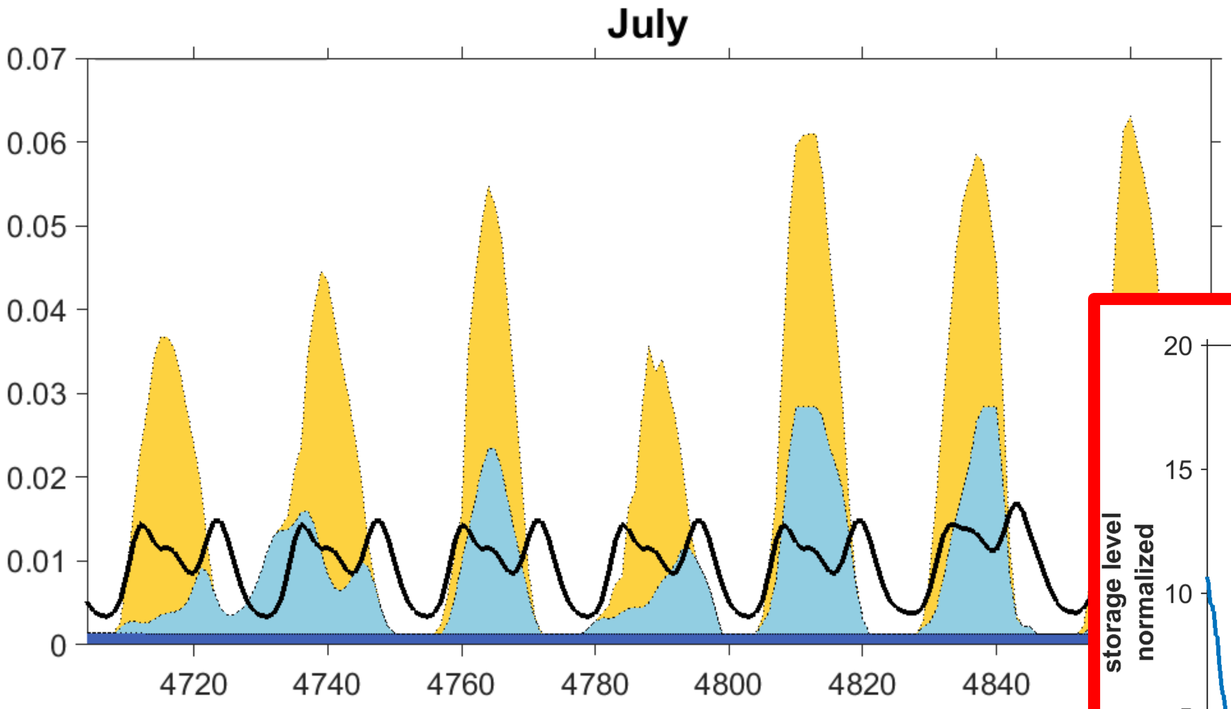


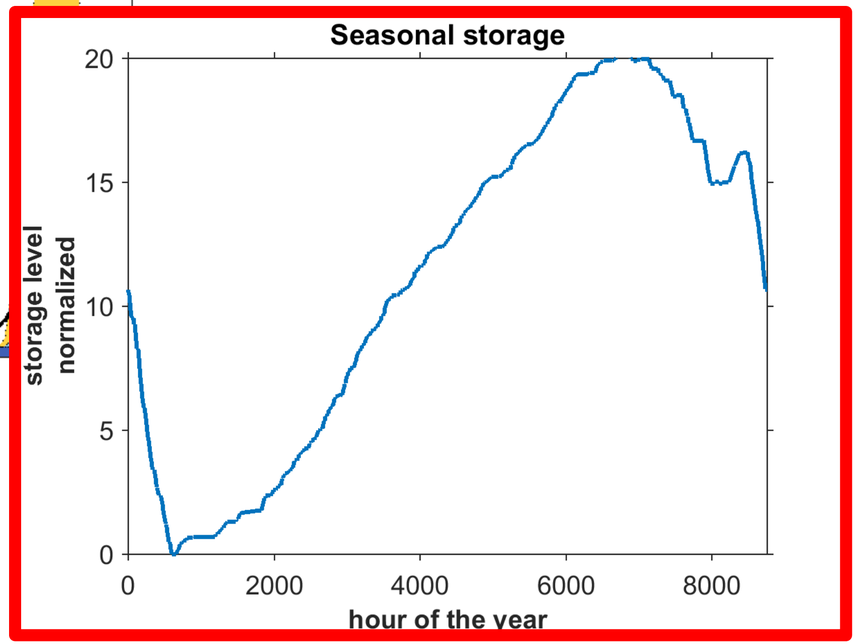

Bridging short-term gaps with efficient storage systems:

- Batteries
- Pump storage
- Thermal storage
- …

*Source: PHI*

# Renewables in Summer

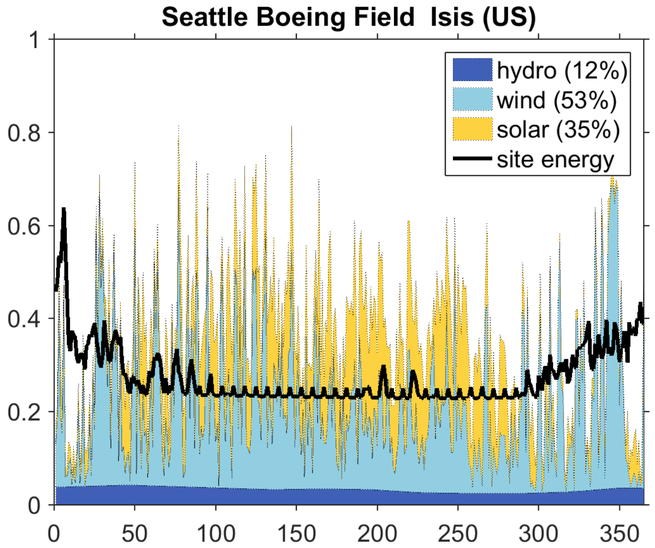


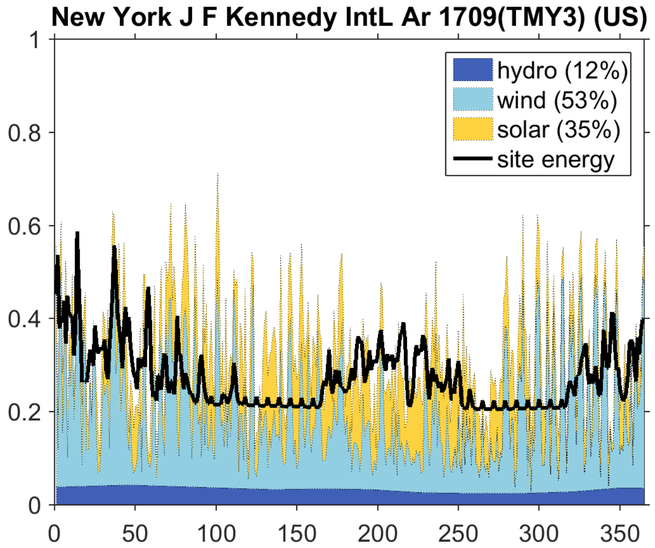



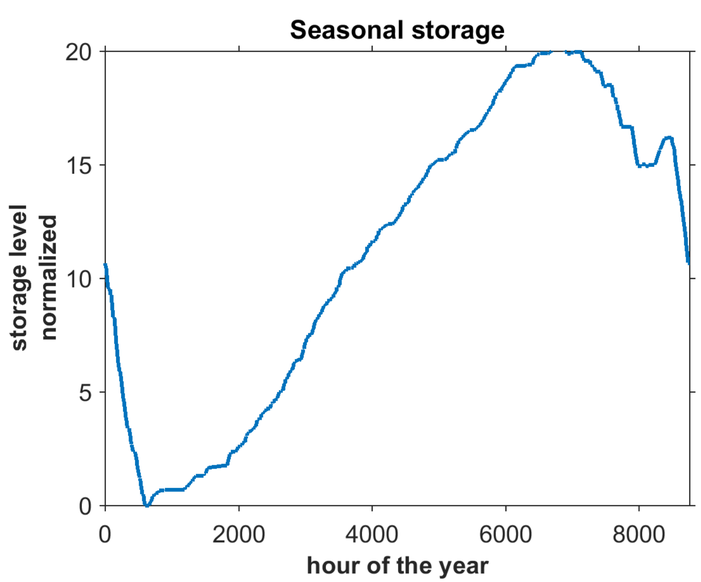

**Energy surplus during summer!!**
**= Seasonal storage required**

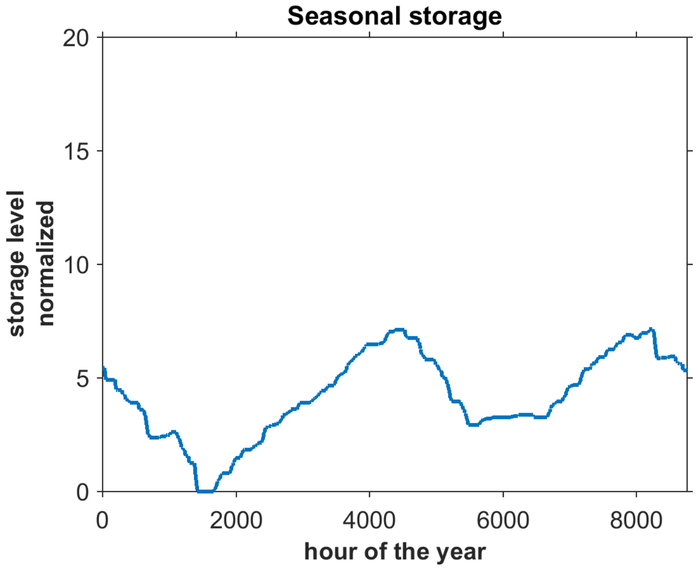
*Source: PHI*

# Seasonal Storage



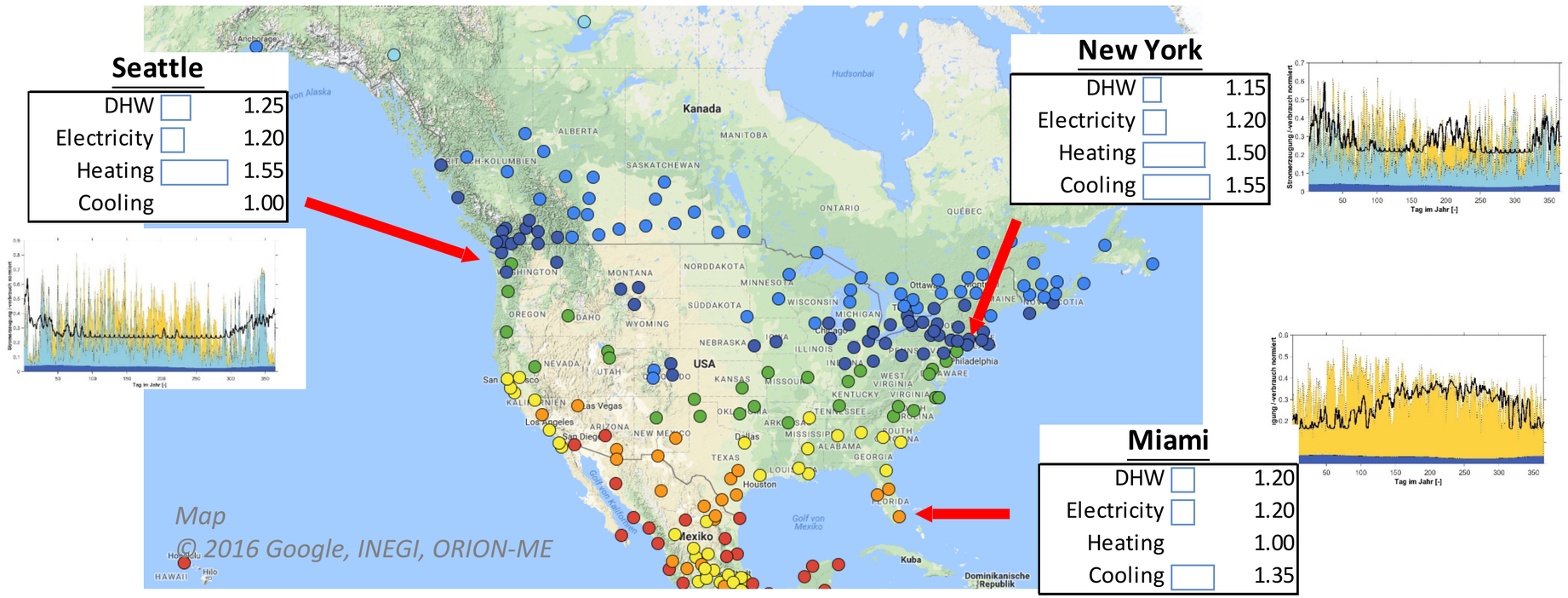




*Source: PHI*

# Local Variations

- PER weighting factors vary for:
  1. Different locations
  2. Different load profiles (heating, cooling, hot water, electricity)




*Source: PHI*

# Enabling an All-Renewable Energy Supply

**with the PER Approach**

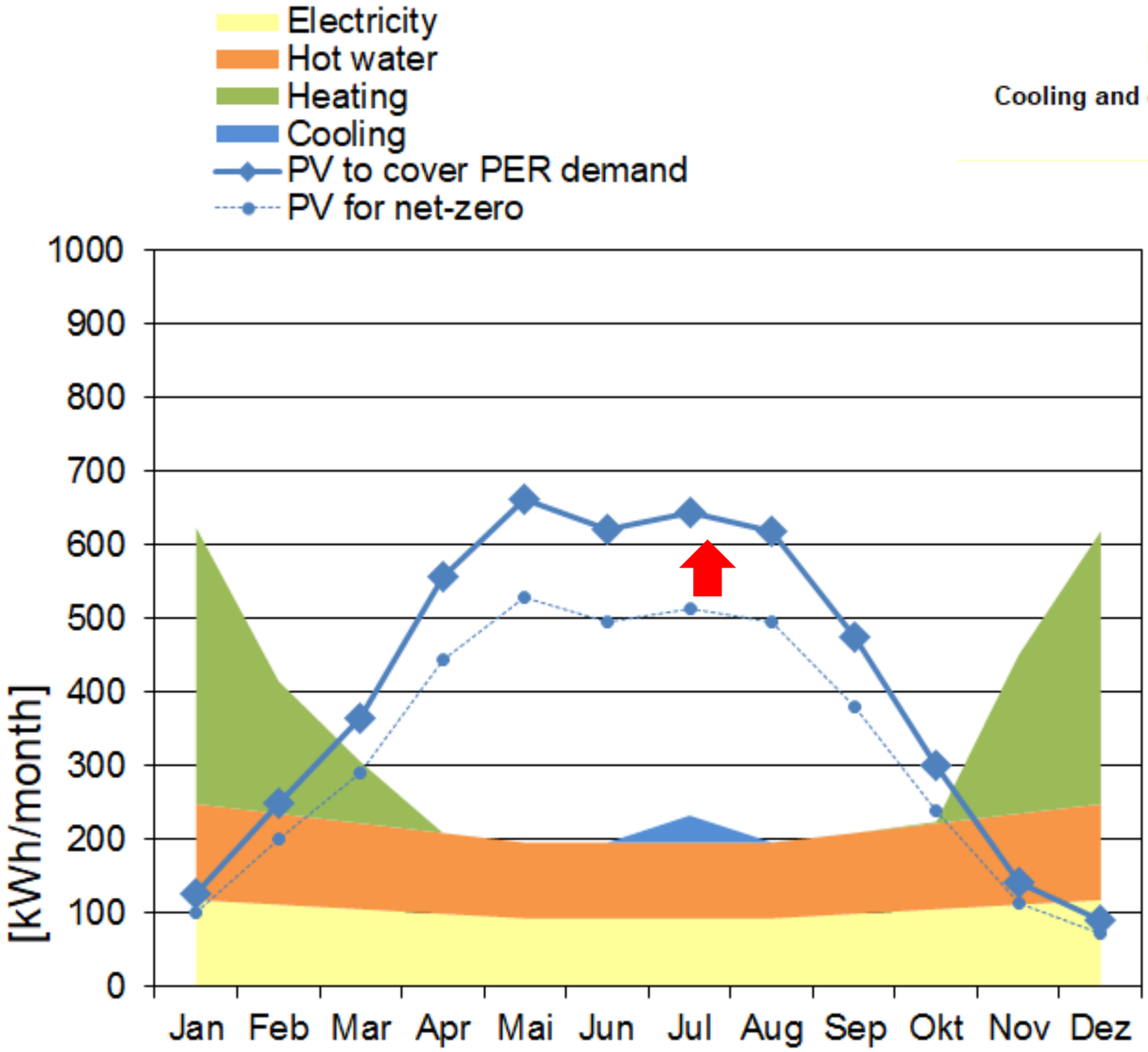
- The impact of heating / cooling is weighted in the context of the regional renewable resource availability
  (mostly higher impact of heating due to seasonal storage)

- The use of **electricity** is rated more favorably than in a conventional primary energy approach
  (especially in combination with heat pump systems)

- The use of **biomass** is only encouraged to a limited budget
  (extremely valuable, competitive & limited resource)

- A moderate use of **gas and other fossil fuels** becomes important

# Zero Energy?




| | | |
|---|---|---|
| Heating demand | kWh/(m²a) | 15 |
| Cooling and dehum. Demand | kWh/(m²a) | 1 |
| PER demand | kWh/(m²a) | 31 |

The PER approach takes into account losses, e.g. it's a more „honest" zero-energy system!

**Required PV area**
**(German climate)**
**Net-zero = 32 m²**
**PER-zero = 40 m²**

*Source: PHI*

# Uniform Accounting

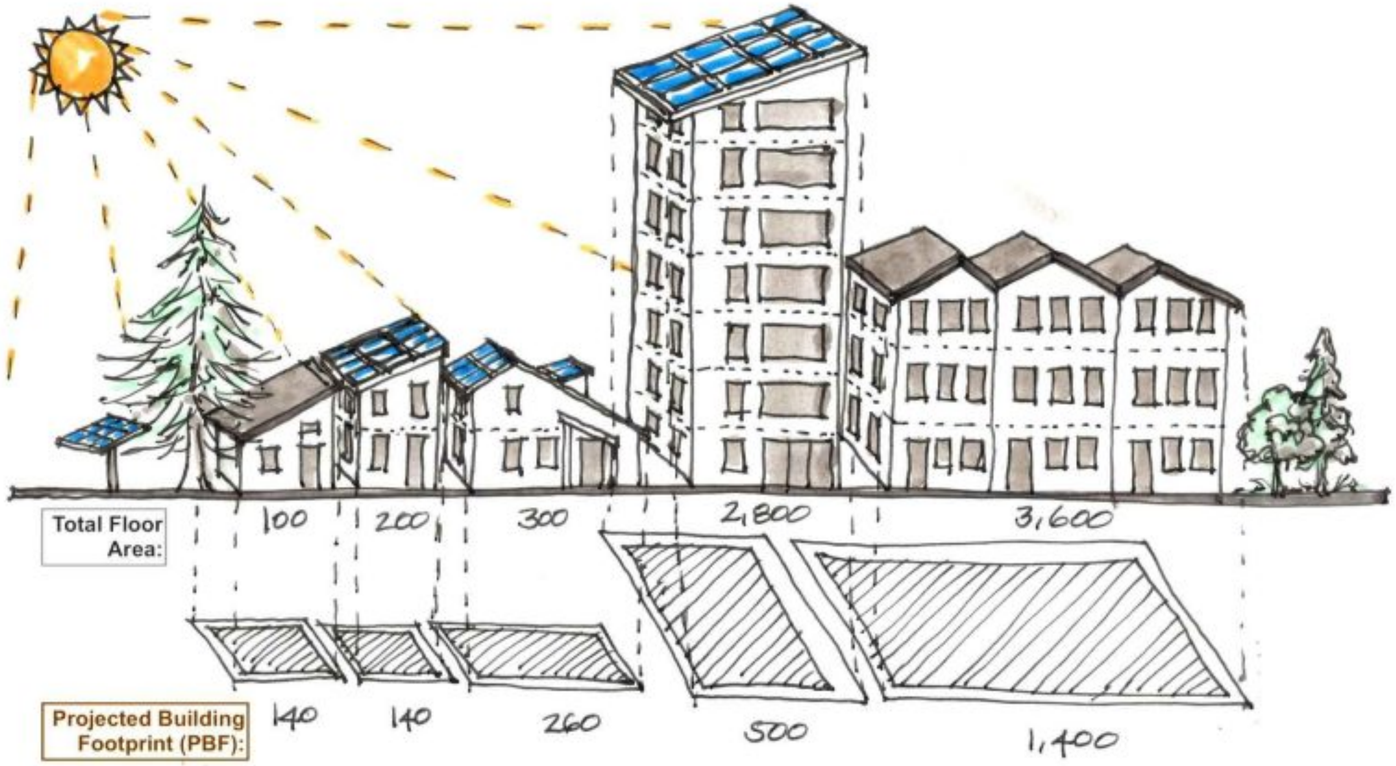



Illustration by Bronwyn Barry, Passive House California

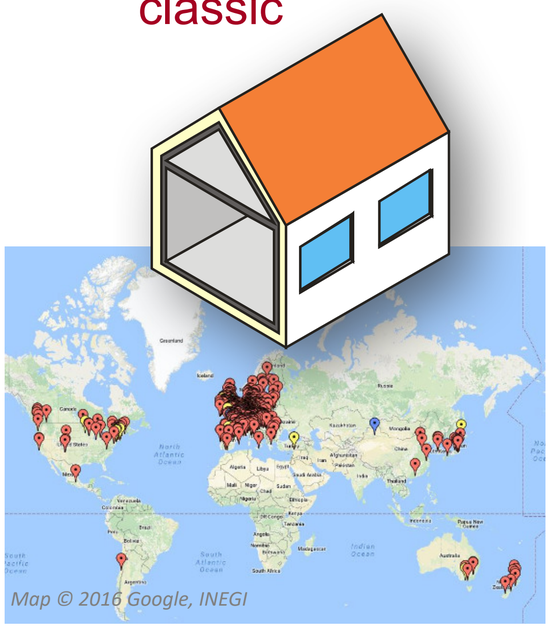
- Net-zero / net-plus energy is often misleading
  *e.g. multistory buildings are discriminated despite their advantages*

- Suggested approach: Independent rating of RE and efficiency.
  - **Building's footprint area as the reference for renewables**
  - **Taking off-site production into account**

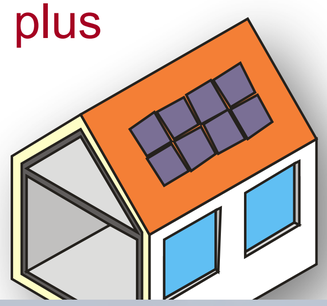
# PER Applied

Basic requirement: Very low useful energy demand ≤ 4.75 kBTU/(ft² yr)

classic




plus



Vienna |
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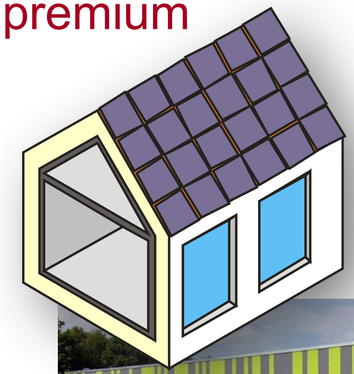
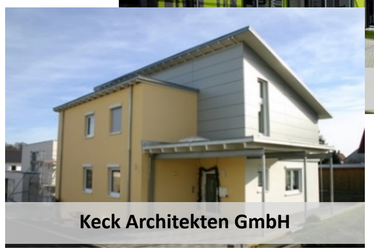
...

premium



bg architektur



Keck Architektenn GmbH

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+ Renewable energy generation (PER supply)
+ increased overall efficiency (PER demand)


# Good Energy Haus

Single Family Home - Minneapolis, MN - 2020

First certified **Passive House Plus** in Minneapolis - New Construction

# Good Energy Haus

- Exterior Walls: U-0,95 (W/ $m^2K$)
- Slab: U 0,184 (W/ $m^2K$)
- Roof: U 0,079 (W/ $m^2K$)
- Windows:
  $U_f$ 0.81 (W/ $m^2K$), $U_g$ 0,53 (W/ $m^2K$), g 0.55
- HRV 85% eff
- Airtightness: $n_{50}$ 0.22/ h
- Heating load: 19 W/ $m^2$
- Cooling Load: 9 W/ $m^2$
- Primary Energy Demand: 80 kWh/ ($m^2$a)
- PER Demand: 37 kWh/ ($m^2$a)
- Generation of Renewable Energy: 104 kWh/ ($m^2$a)

# Peak Load and On-Site Offset

Display monthly summary for: Heat & AC Total

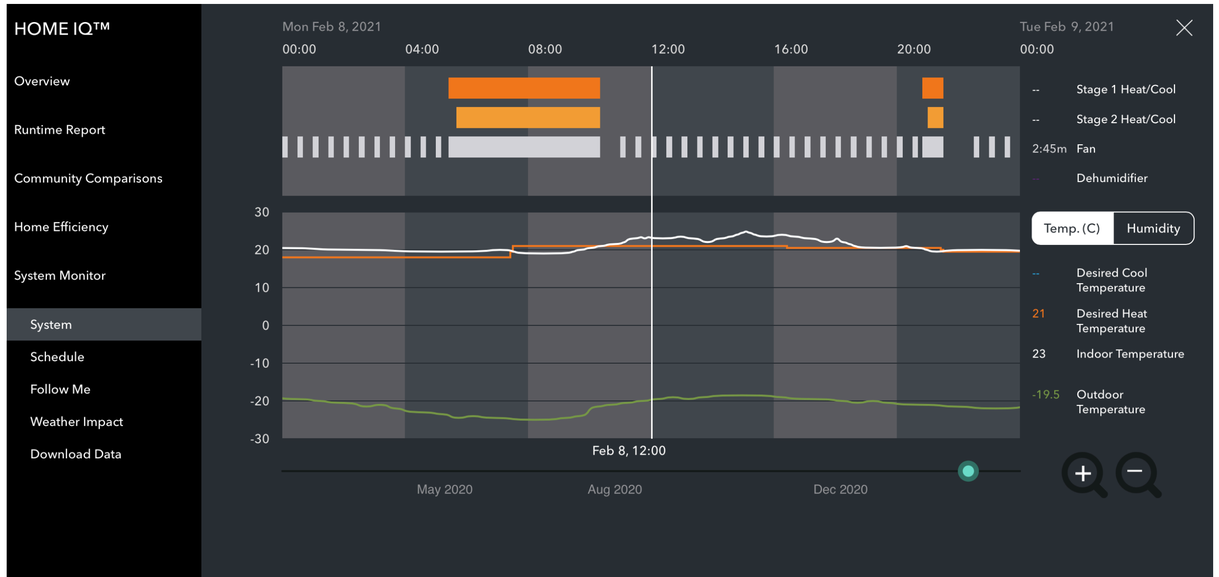
| Heat & AC Total [kWh] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| 2021 | 663 | 733 | 31[1] | - | - | - | - | - | - | - | - | - | 1427 |
| 2020 | - | - | - | - | - | - | - | - | - | - | - | 294[2] | 294 |

**Footnotes:**

[1]: Ending 10:38am Mar 10, 2021.
[2]: Starting 07:02pm Dec 15, 2020.

## Monitoring in progress

- Not a full year, yet: About 2,800 kWh/ yr predicted by PHPP for home
- Home and garage on same system (no individual monitoring available)

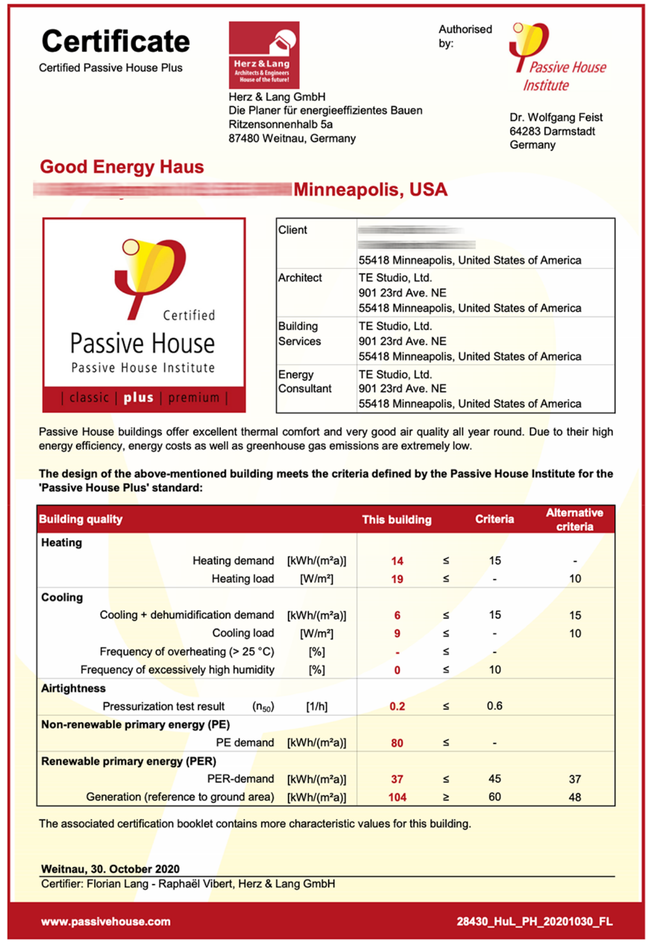



| Since Jan 1st | |
|---|---|
| –Usage | -9,432.332 kWh |
| Generation | 10,195.136 kWh |
| Cooking | -366.464 kWh |
| Dishwasher | -183.775 kWh |
| DHW | -432.849 kWh |
| Heat & AC Total | -2,850.765 kWh |
| Laundry | -503.744 kWh |
| Media Center | -155.585 kWh |
| Network | -389.359 kWh |
| Plug Loads | -2,087.551 kWh |
| Refrigeration | -259.785 kWh |
| Vehicle | -1,577.241 kWh |
| Ventilation | -587.416 kWh |
| Garage Recepts North | -13.892 kWh |
| Garage Recepts South | -23.907 kWh |

# Learning from Good Energy Haus

- Peak heat load reduction achieved
- On-site renewables provide 100% of annual site energy consumption (including transportation)

**Passive House delivers sustainable, climate-neutral, cold-climate performance.**



**Certificate**

Certified Passive House Plus

Herz & Lang GmbH
Die Planer für energieeffizientes Bauen
Ritzensonnenhalb 5a
87480 Weitnau, Germany

Authorised by:

Passive House Institute

Dr. Wolfgang Feist
64283 Darmstadt
Germany

**Good Energy Haus**

[redacted] **Minneapolis, USA**

Certified Passive House Institute
| classic | **plus** | premium |

| | |
|---|---|
| Client | [redacted]<br>55418 Minneapolis, United States of America |
| Architect | TE Studio, Ltd.<br>901 23rd Ave. NE<br>55418 Minneapolis, United States of America |
| Building Services | TE Studio, Ltd.<br>901 23rd Ave. NE<br>55418 Minneapolis, United States of America |
| Energy Consultant | TE Studio, Ltd.<br>901 23rd Ave. NE<br>55418 Minneapolis, United States of America |

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

**The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the 'Passive House Plus' standard:**

| Building quality | | This building | | Criteria | Alternative criteria |
|---|---|---|---|---|---|
| **Heating** | | | | | |
| Heating demand | [kWh/(m²a)] | 14 | ≤ | 15 | - |
| Heating load | [W/m²] | 19 | ≤ | - | 10 |
| **Cooling** | | | | | |
| Cooling + dehumidification demand | [kWh/(m²a)] | 6 | ≤ | 15 | 15 |
| Cooling load | [W/m²] | 9 | ≤ | - | 10 |
| Frequency of overheating (> 25 °C) | [%] | - | ≤ | - | |
| Frequency of excessively high humidity | [%] | 0 | ≤ | 10 | |
| **Airtightness** | | | | | |
| Pressurization test result ($n_{50}$) | [1/h] | 0.2 | ≤ | 0.6 | |
| **Non-renewable primary energy (PE)** | | | | | |
| PE demand | [kWh/(m²a)] | 80 | ≤ | - | |
| **Renewable primary energy (PER)** | | | | | |
| PER-demand | [kWh/(m²a)] | 37 | ≤ | 45 | 37 |
| Generation (reference to ground area) | [kWh/(m²a)] | 104 | ≥ | 60 | 48 |

The associated certification booklet contains more characteristic values for this building.

**Weitnau, 30. October 2020**
Certifier: Florian Lang - Raphaël Vibert, Herz & Lang GmbH

www.passivehouse.com 28430_HuL_PH_20201030_FL

# Conclusions

- The 2,000-Watt Society is a strong vision for climate-neutrality, which leads us to optimized investments in efficiency and the clean grid
- The Passive House building energy standard (and EnerPHit for retrofits) provides the foundation for the effective and efficient use of the clean grid with storage
- The Passive House load profile is much more compatible with renewable energy sources with storage than current code, or other standards, which are less efficient
- The Passive House PER approach transparently illustrates “true” net-zero and climate-neutrality in the built environment and leads us down the path of adequate and climate-zone specific load shifting and energy storage solutions

# Resources

- 2,000-Watt Society: https://ourworld.unu.edu/en/2000-watt-society
- Passive House: https://passivehouse.com
- Passive House PER: https://passipedia.org/basics/energy_and_ecology/primary_energy_renewable_per


# Thank You!

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