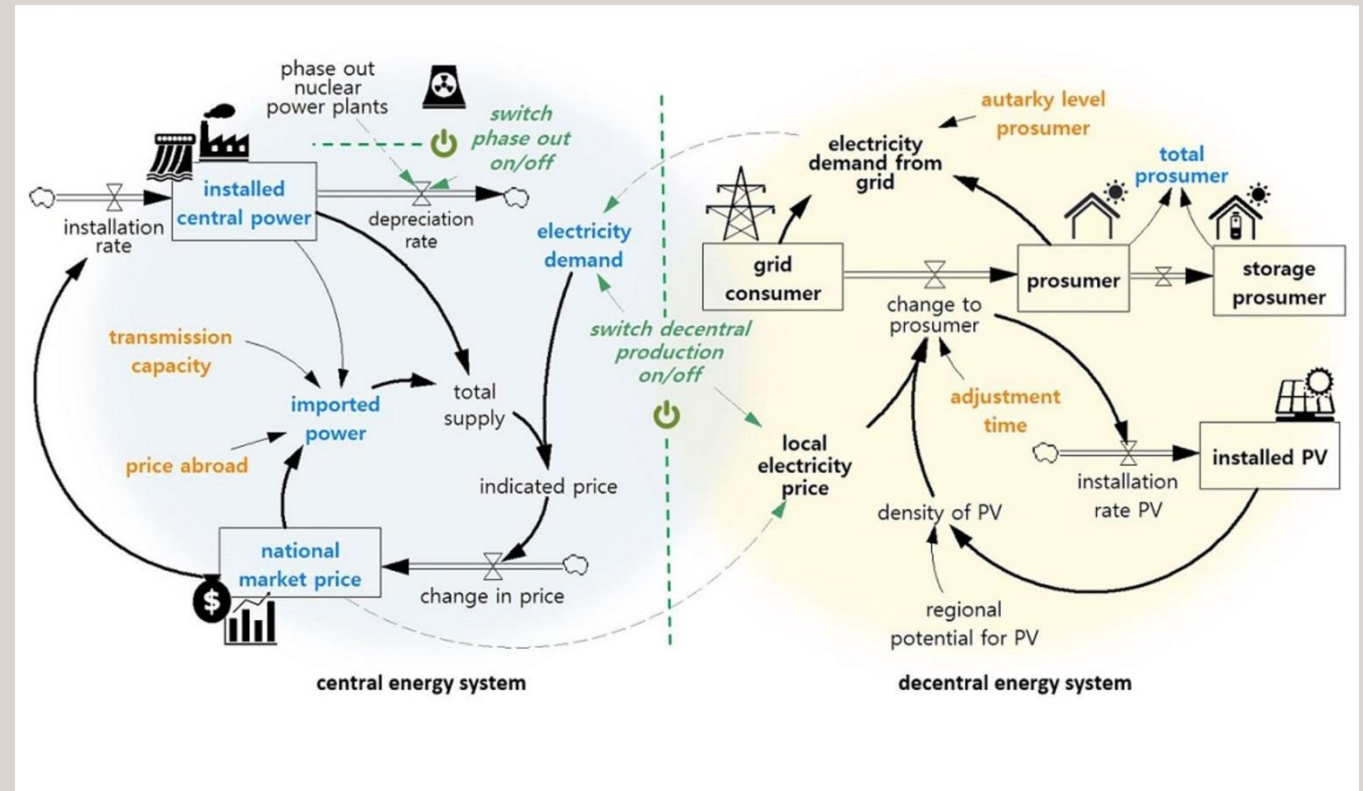


# Decentralized versus Centralized Energy System Layouts

Some considerations

05-04-2018

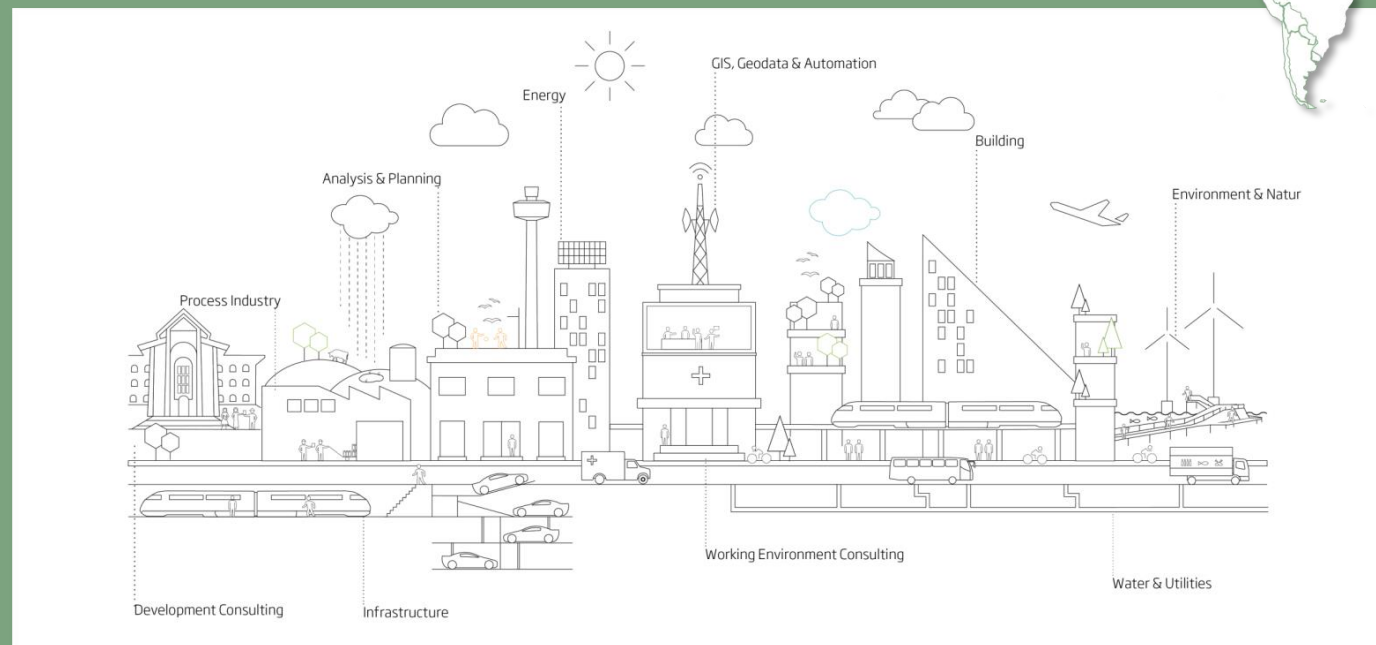
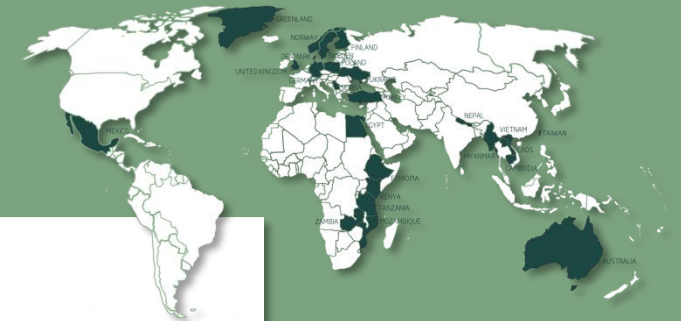


Why this question?

# About NIRAS

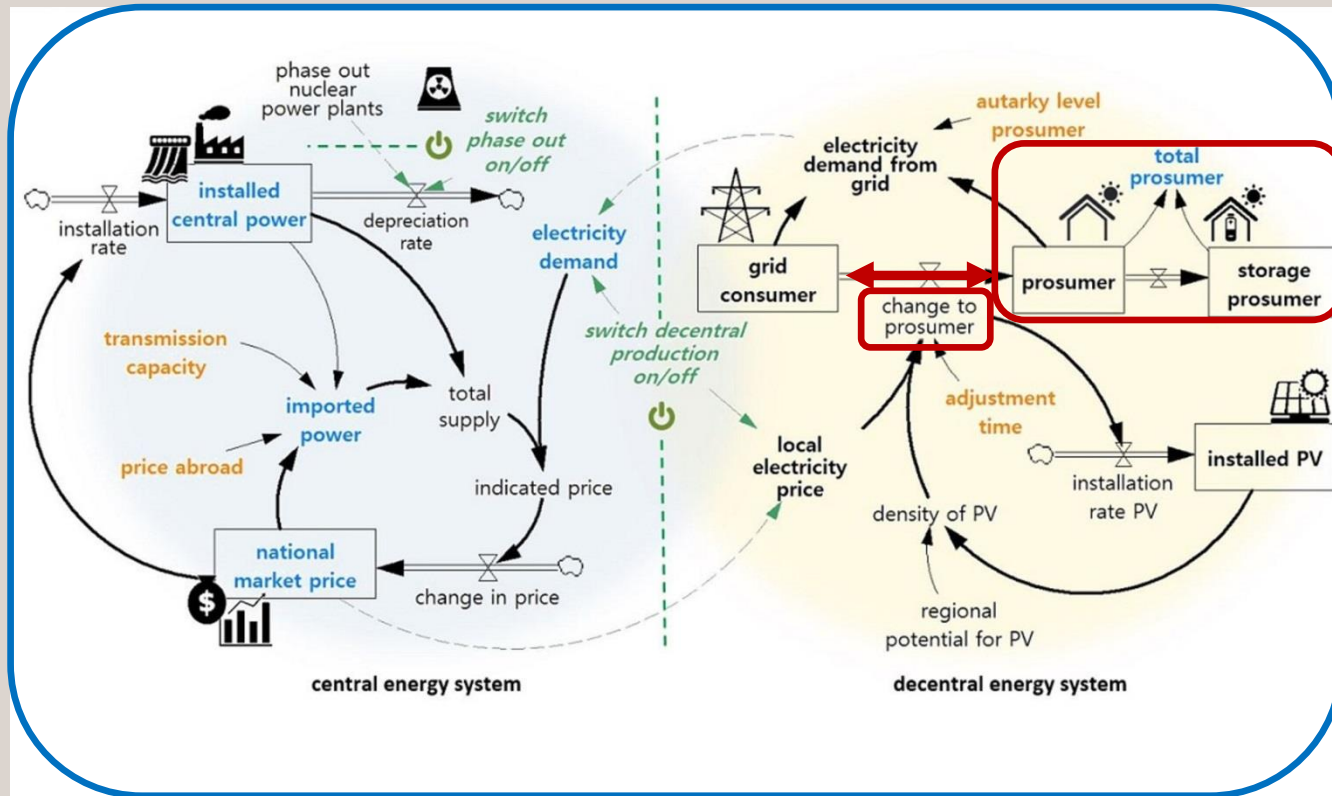
- More than 2,000 experts
- design holistic, sustainable solutions
- in over 80 countries
- during more than 100 years

*We transform our customers' visions and challenges into sustainable solutions.*



# Why this question?

Is it rational to have (non-autonomous prosumers) in a grid connected society?



Autonomous prosumer

Grid connected prosumer

Affected grids

> does it make sense?

# Decentralized Renewables Won't Fuel Modern Cities

Why We Can't Ignore Fundamentals of Power Density



*There are fundamental physical limits to how much energy we can extract from renewable resources for a given area of land, particularly for an increasingly urban human society. Yet, Western environmentalists calling for distributed energy as a viable solution routinely ignore extremely high population density. For example, of the world's 200 largest urban areas, 17 are in India. Covering any of the cities entirely in solar panels will generate less than half of their energy needs. If the citizens of these cities are to attain a high quality of life they will require large centralized energy generation. This is not a matter of ideological preference, but of engineering reality.*

A part of the answer  
.... to be considered

... is **density**

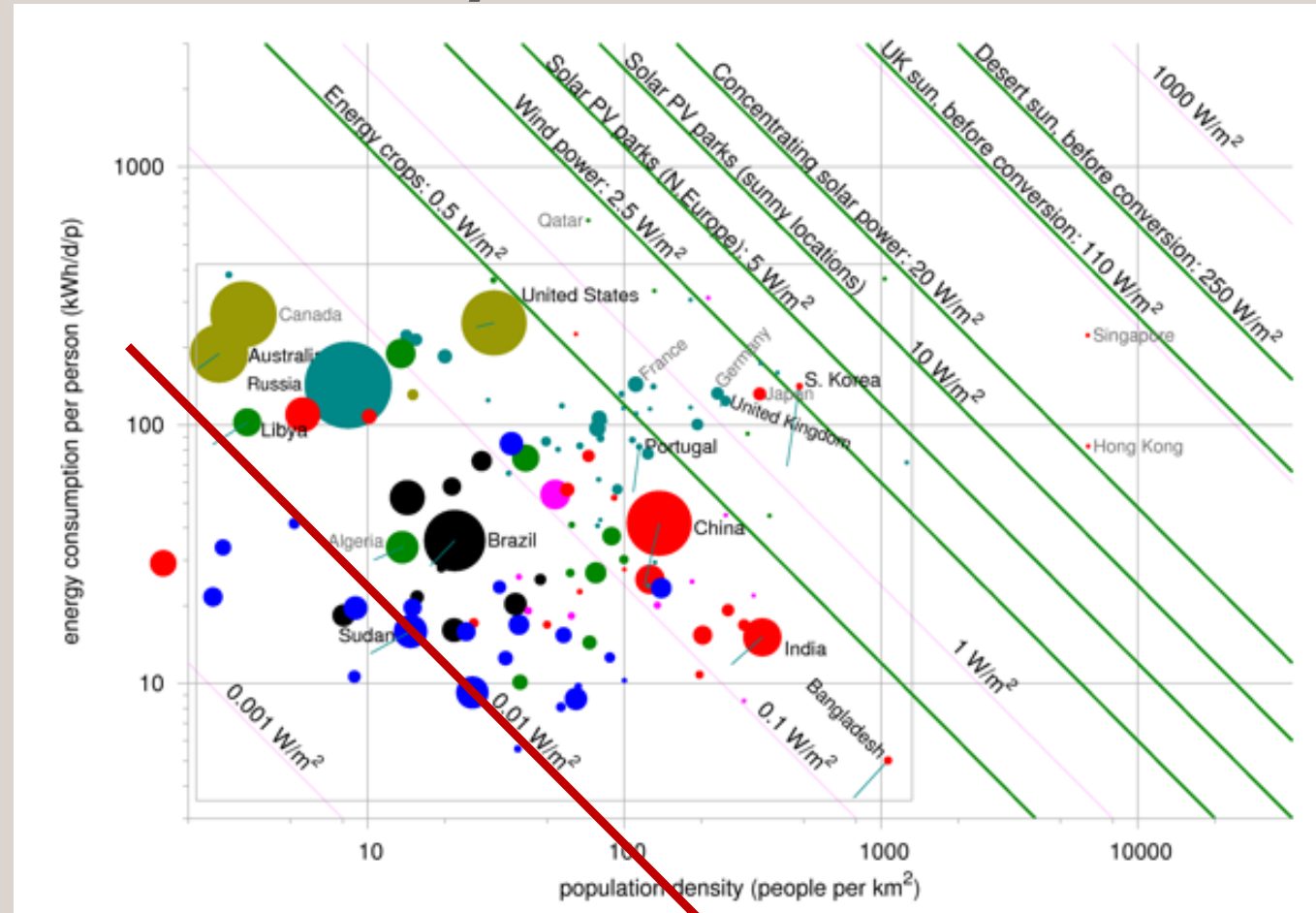
Here's a discussion on how  
density impacts distributed  
energy production

<https://thebreakthrough.org/index.php/programs/energy-and-climate/decentralized-renewables-wont-fuel-modern-cities>

# Some indication on density

## Power density versus population density

- Wind farm (large scale) 1-3 W/m<sup>2</sup> in avg.
- PV farms (large scale) 5 W/m<sup>2</sup> (Germany)  
20 W/m<sup>2</sup>  
(Australien dessert)
- Bio 0,5 W/m<sup>2</sup>
- Power plants (fossile) 100-1000 W/m<sup>2</sup>



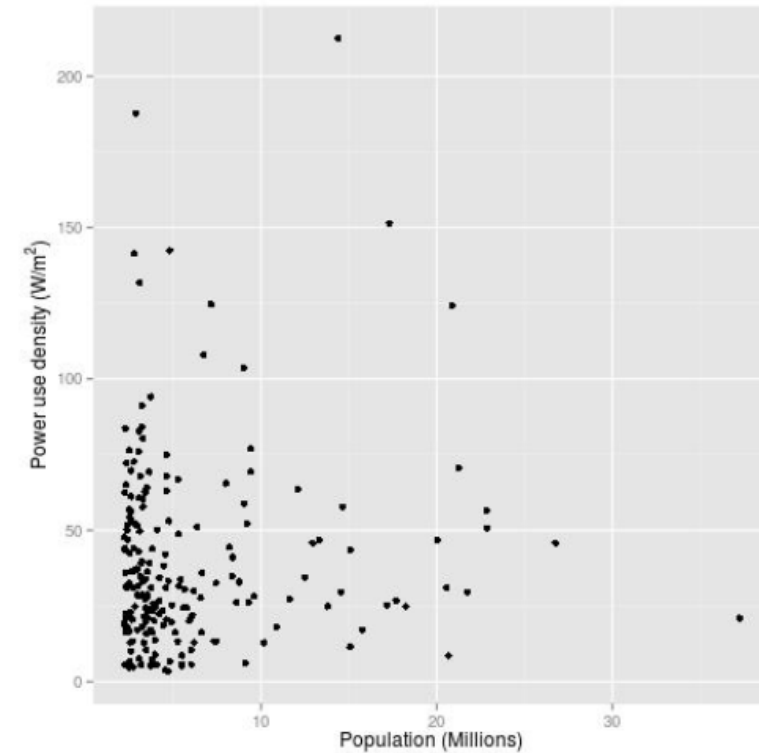
Global land energy density in average

<https://withouthotair.blogspot.dk/2013/06/david-mackays-map-of-world-update.html>

Minor conclusion

Density matters

... so does energy solutions



In total, 10 cities would have power density greater than  $100 \text{ W/m}^2$ , 56 would have power density greater than  $50 \text{ W/m}^2$ , while 181 would have power density of over  $10 \text{ W/m}^2$ . Ninety percent of the planet's 200 largest cities almost certainly cannot be powered predominantly by local renewable energy. The population densities of these cities are not significantly different than the rest of the world's cities, so we can conclude that the vast majority of cities cannot be powered by local renewables. And this suggests very serious limits to the role of local distributed energy in a world where more than 70 percent of us will probably live in cities.

# Research Question Proposal

How does density affect the usefulness of individual prosumption?

Thanks for listening

*Alfred Heller*

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# Energy chains

## Production ✓

- ✓ PV
- ✓ Solar thermal
- ✓ Solar thermal el
- ✓ Wind
- ..

## Transformation ✓

- ✓ direct
- ✓ Heat pumps
- ✓ El-heat/cool
- ✓ Gas-heat/cool
- ✓ Solar-absorption heat/cool

## Usage ✓

- ✓ Comfort (heat/cooling)
- ✓ Water
- ✓ ... controlled
- ✓ ... storage
- ✓ ... flexibility

Robustness, safety of delivery, socio-economical efficiency