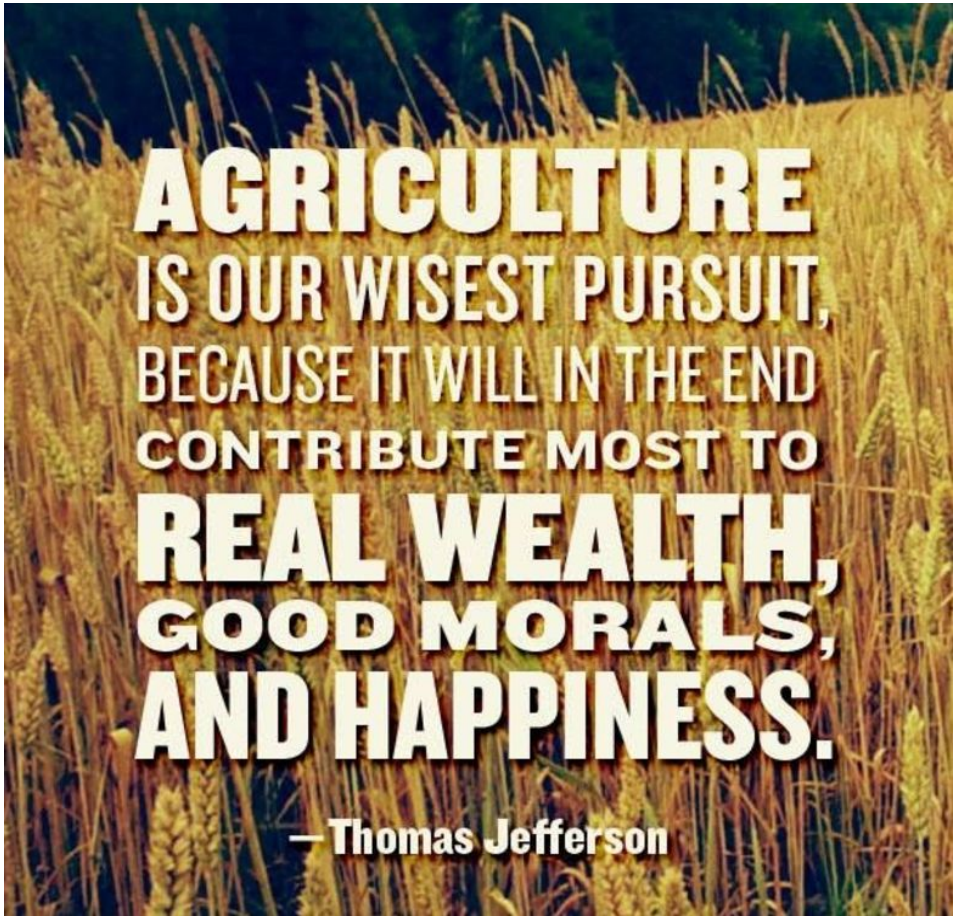


“We do not inherit the Earth from our ancestors, we borrow it from our children.”
-Native American Proverb

“Plants and animals are systems that run on sunshine, dirt, and rain. Humans are an overlay network built on these systems.”
-Urban Farmer

embodied carbon is often 20-50% of the whole life energy and carbon of a building

circular ecology

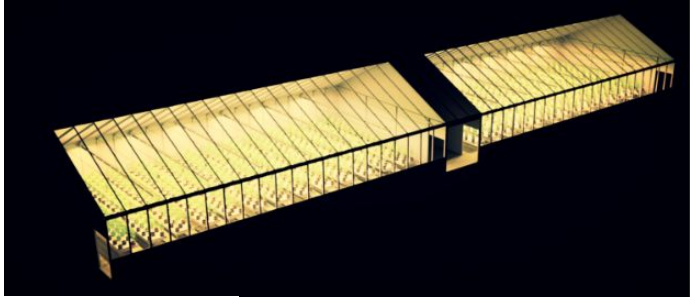
Resource efficiency at its best
Energy - Carbon - Water - Waste

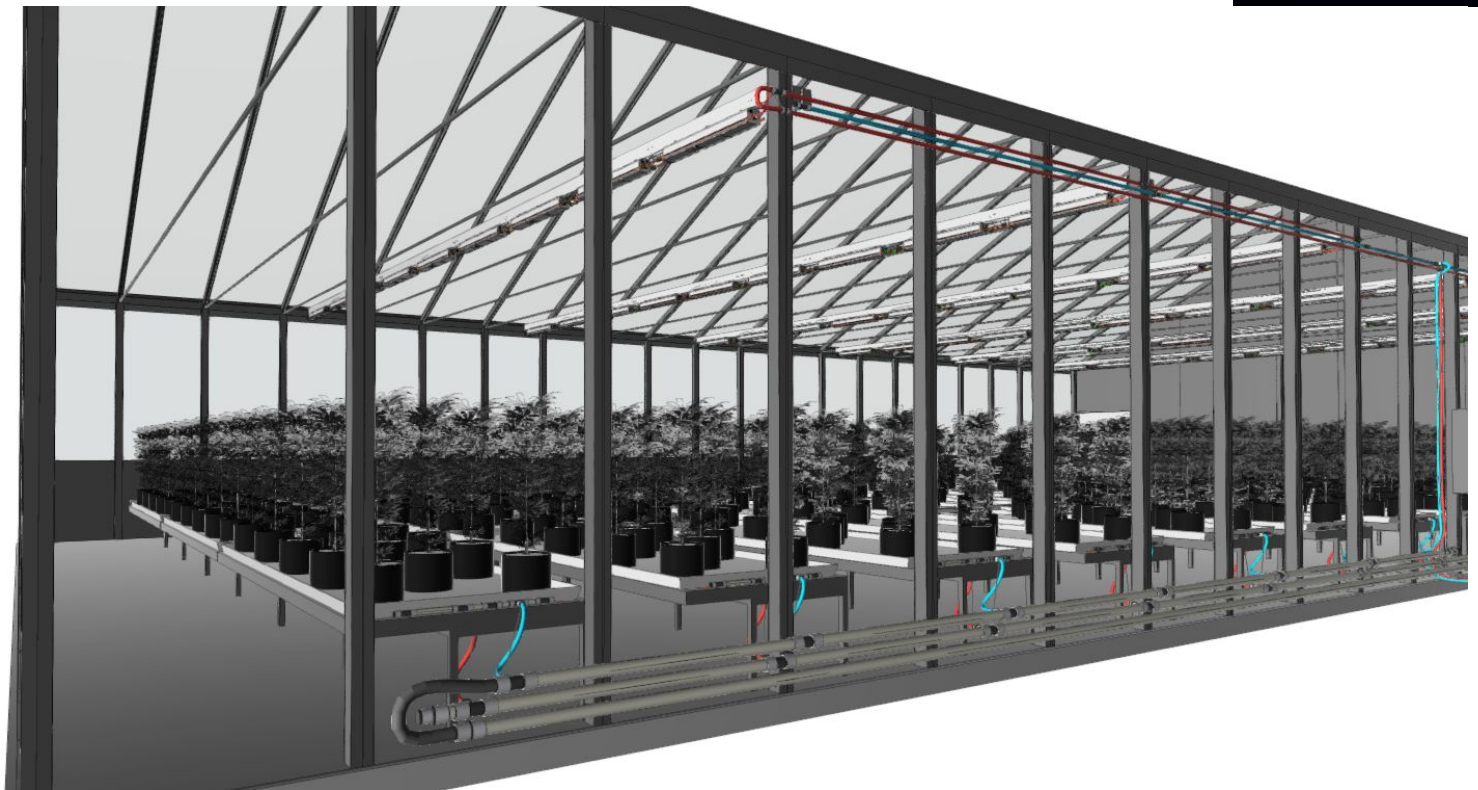
Can intensive farming increase afforestation? YES!

Can intensive farming reduce sprawl? YES!

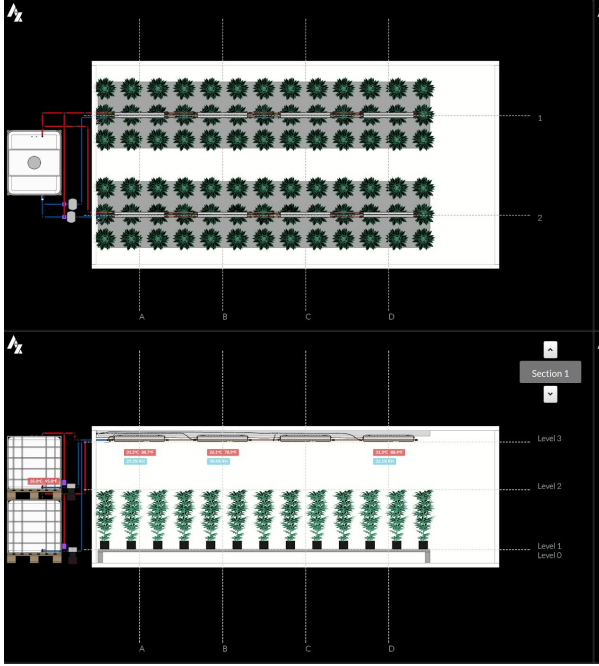
Are greenhouses “exempt” from permitting, Group U (unoccupied) or F1(factory)?

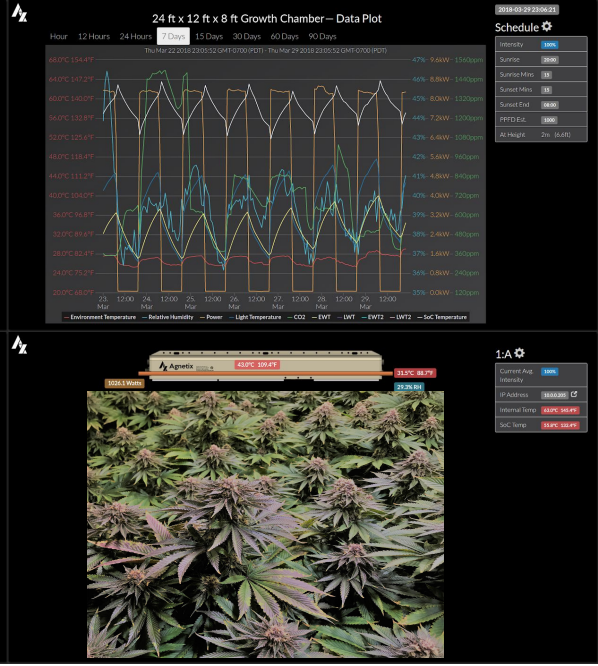
Greenhouses

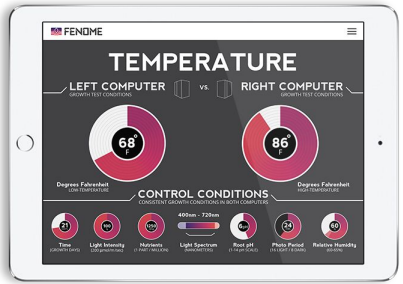


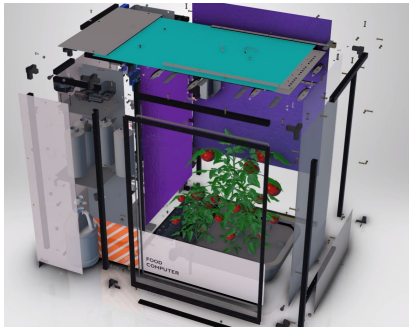


Growth Chambers and Rooms

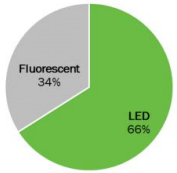






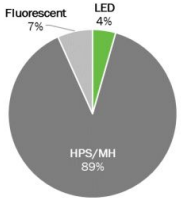


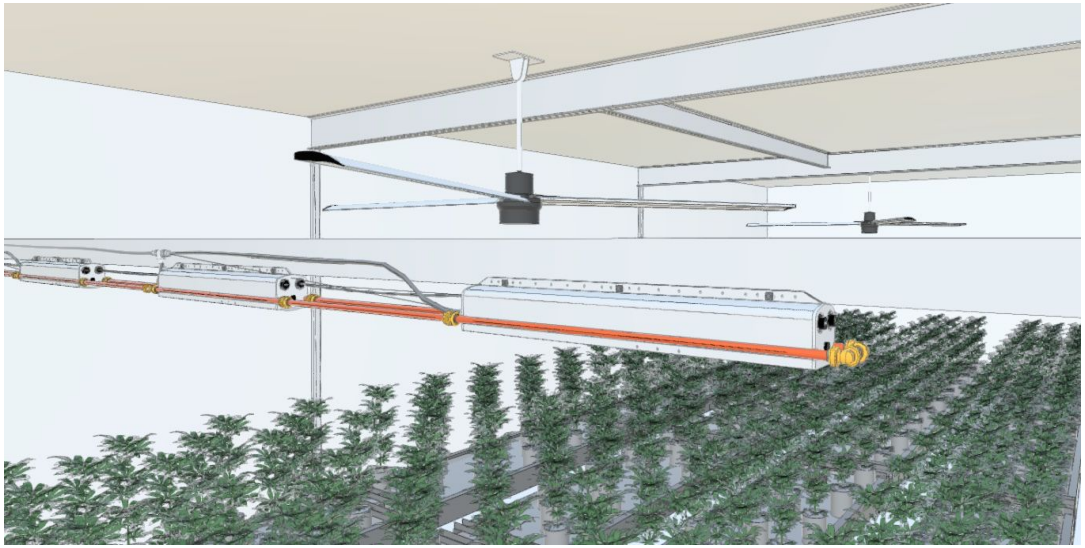
1% Vertical Farming
(10% savings)

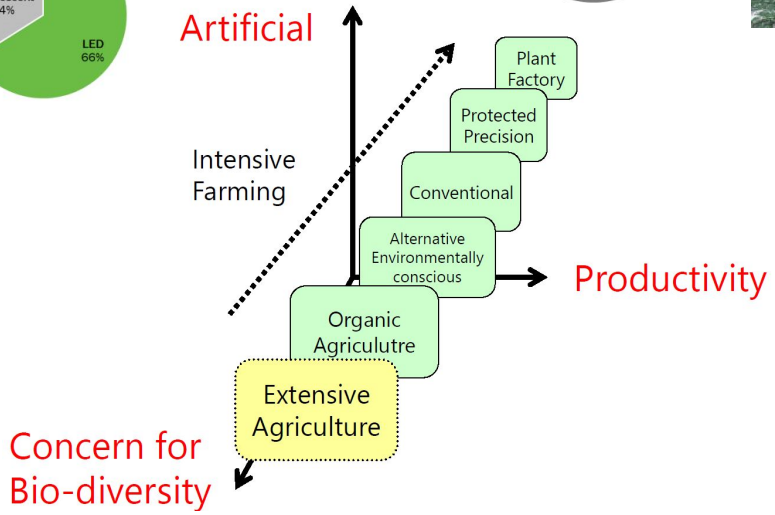


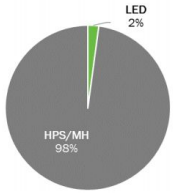
89%

Non-Stacked
Indoor
(41% savings)









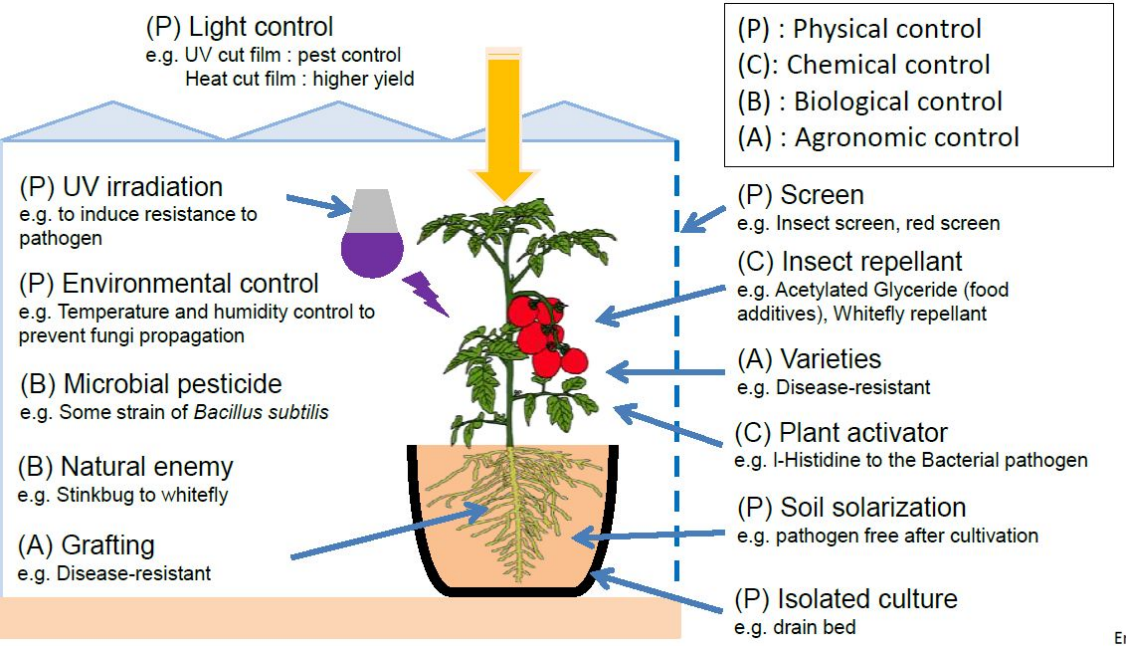
10%

Supplemental
Greenhouse
(29% savings)

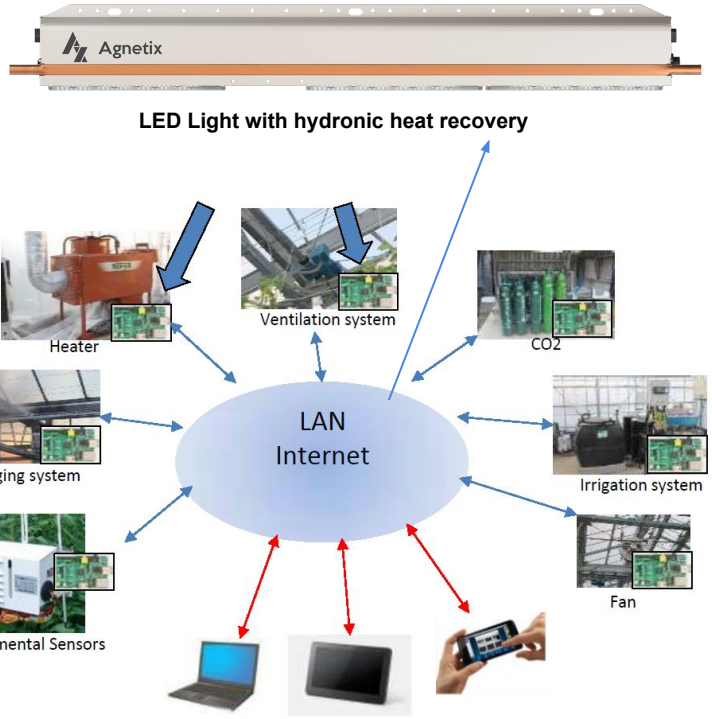
Controlled Environment Agriculture (CEA) Incentives and Financing

Qualified Farmers + PG&E + Energy Efficiency Engineers

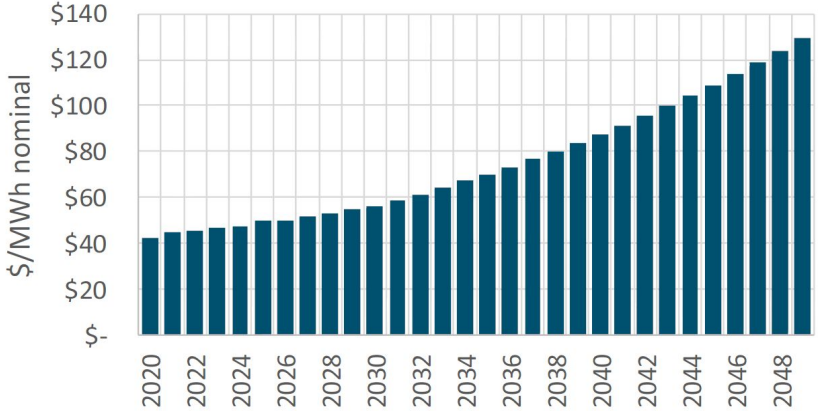
Genetics, Nutrients & Environment



Lighting & HVAC purchase & installation

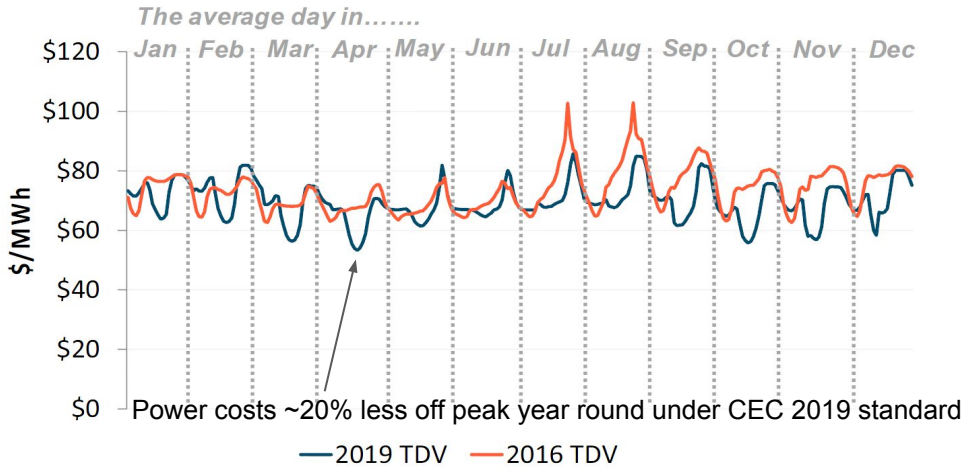


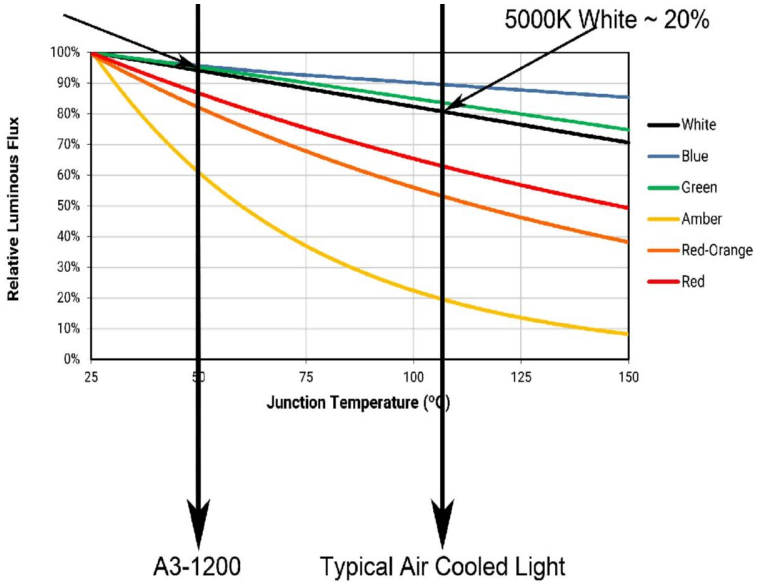
Electrical Energy and TDV



Power costs rising 3x

Horticultural LEDs produce +20% more photons than HID LEDs are an additional ~20% more efficient when actively liquid cooled. Heat recovery and load shifting practices will allow NNZE facility development.





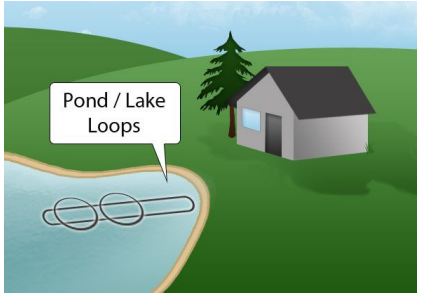
Heat Recovery 50% (lighting watts)
Hydronic Heat Transfer 50% (efficiency improvement)

Thermal Energy Storage Opportunity

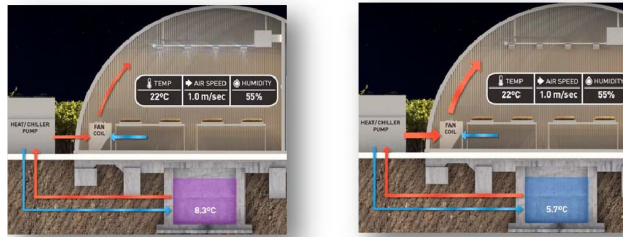
Water source heat pumps

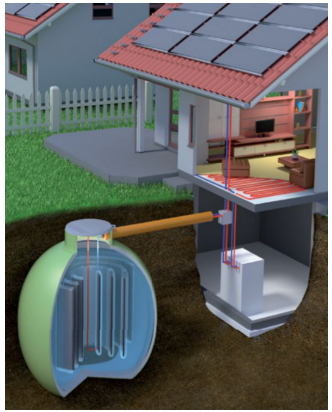
“No cooling needed during the day, and no heating needed at night”

Tank



Lake or river...





Solar Farms

Thermal battery?

PV battery?

Both!

District Heating?

Seasonal storage 475.5 million gallons water

Technical and economical feasibility study of integrating large-scale solar thermal systems into urban district heating

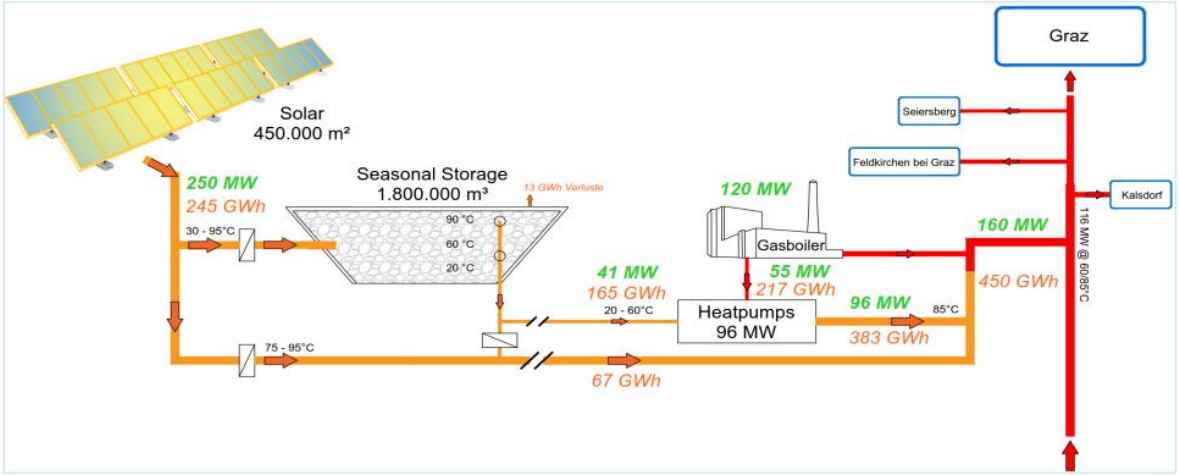
- Assessment of available land
- Dynamic simulation of energy balance
- Economic analysis – Dynamic capital budgeting
- Business case
- Project financing
- Legal framework

Targets

- **Determine optimum size for solar system**
- **Competitive heat price (compared to Gas)**

Concept

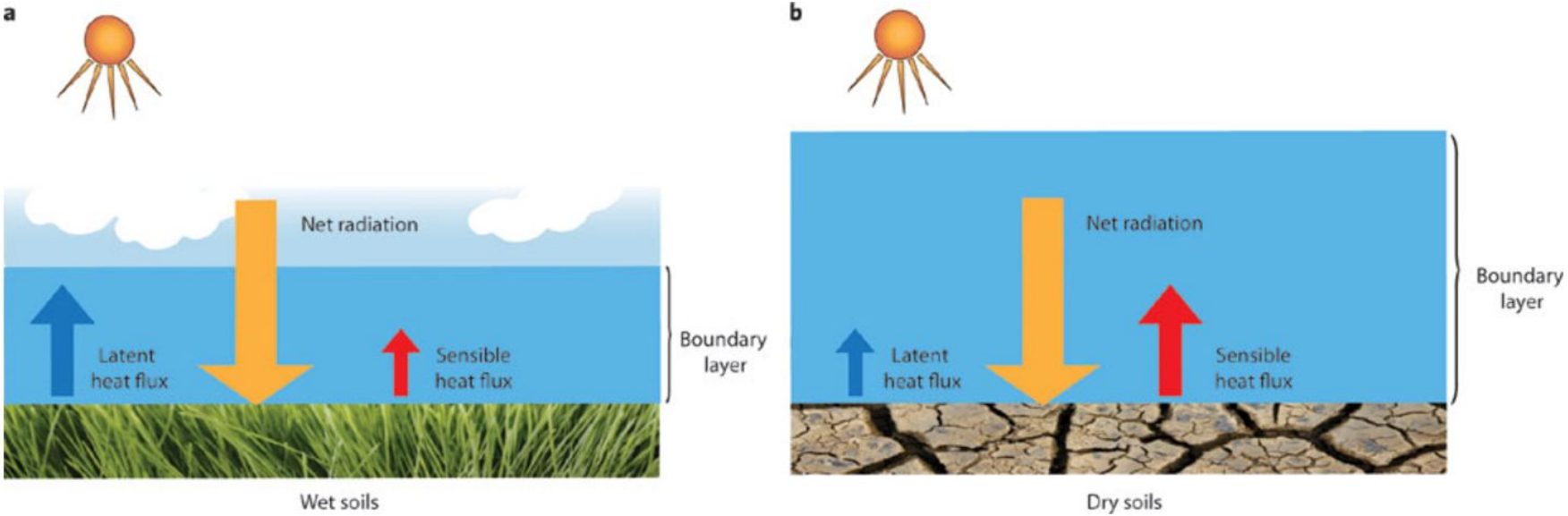
- Large-scale solar thermal plant
- Seasonal pit storage
- Absorption heat pumps (AHPs)
- Simulation scenarios up to:
  - 30% solar fraction
  - 1,000,000 m² collector field
  - 2,000,000 m³ seasonal pit storage



What happens to excess heat in growth rooms?

Latent heat flux from HID lighting creates humidity in greenhouses and growth rooms.

Reducing evaporation is the most important energy savings measure due to cost of dehumidification in closed system.



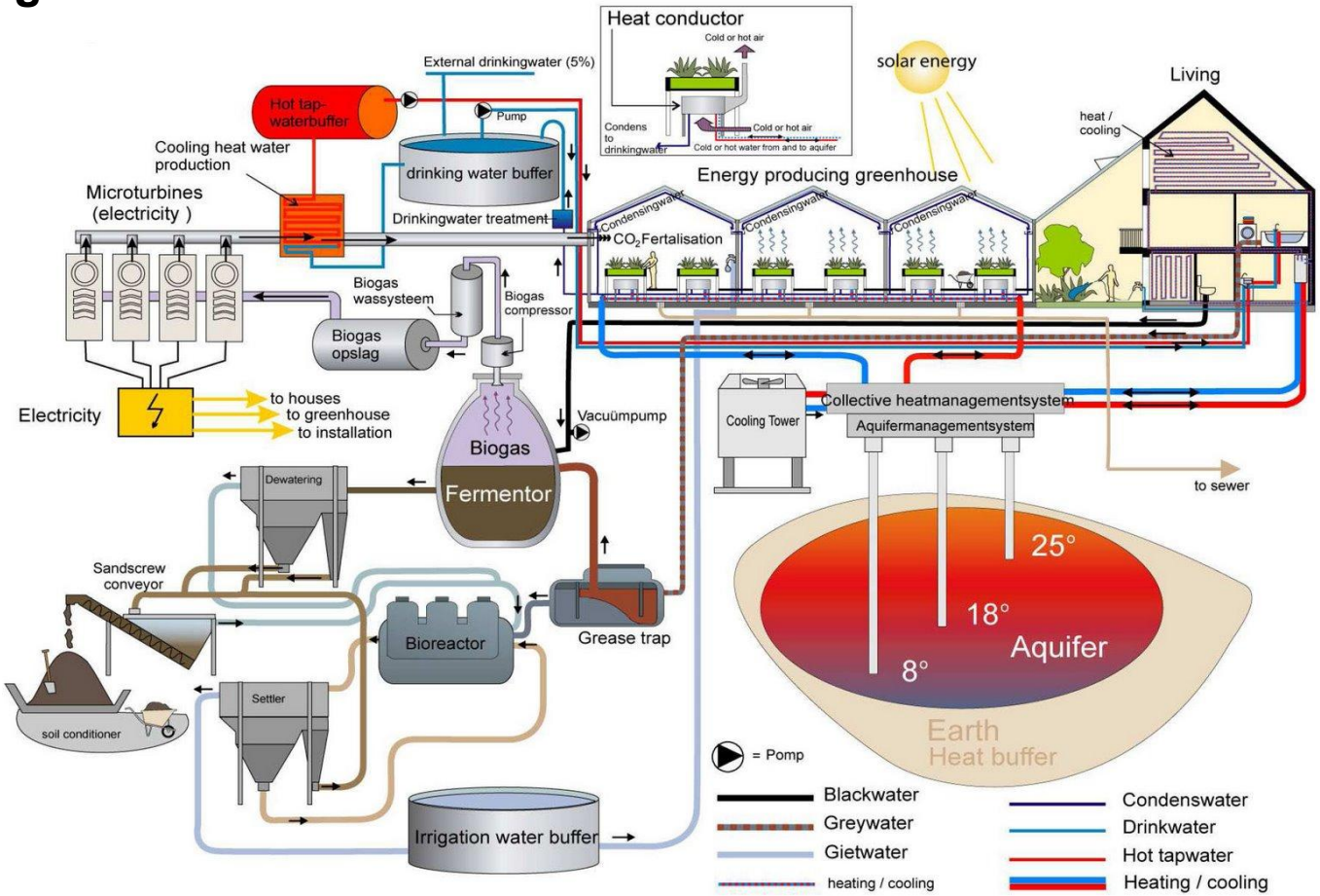
a, In areas with high soil moisture, the latent heat flux by evaporation and transpiration dominates, enhancing cloud formation and a tendency for cooling. **b**, By contrast, if the soil-moisture deficit is high, the dry soils raise the sensible heat flux, producing a deeper, warmer, drier low-level atmosphere. This process inhibits convection and cloud formation and creates a positive feedback loop. Using observations for Europe, Hirschi and colleagues[3] show that the frequency and duration of hot extremes seems to scale with the strength of the antecedent drying of the land surface and that regional climate models can capture this relationship for drier climate regimes.

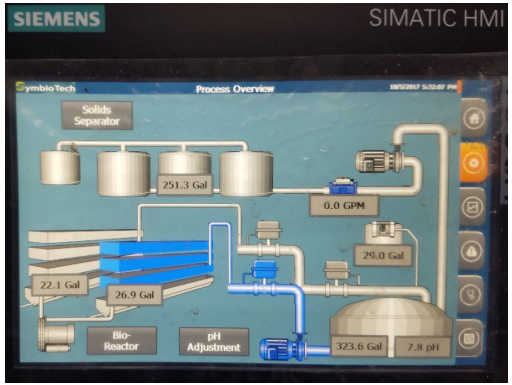
Integrated facility design

- Benchmarking
- Baselines
- Annual energy
- Difficult to model
- Monitoring
- Verification

Facility types

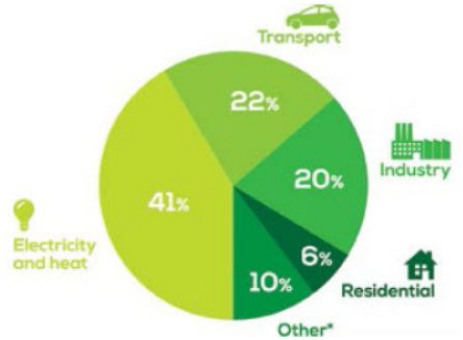
1. Open greenhouse
2. Closed greenhouse
3. Open indoor
4. Closed indoor





Worm farm wastewater and food waste reuse can reduce CO2 emissions

VITALIS
ENVIRONMENT INNOVATION



Biogas

LUND UNIVERSITY

The Potential of Industrial Hemp (*Cannabis sativa* L.) for Biogas Production

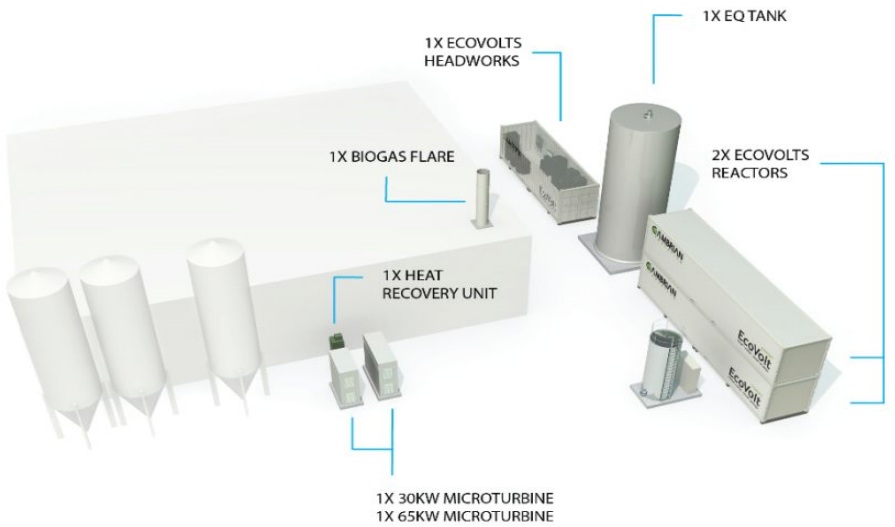
Emma Kreuger

Biotechnology
Doctoral Thesis

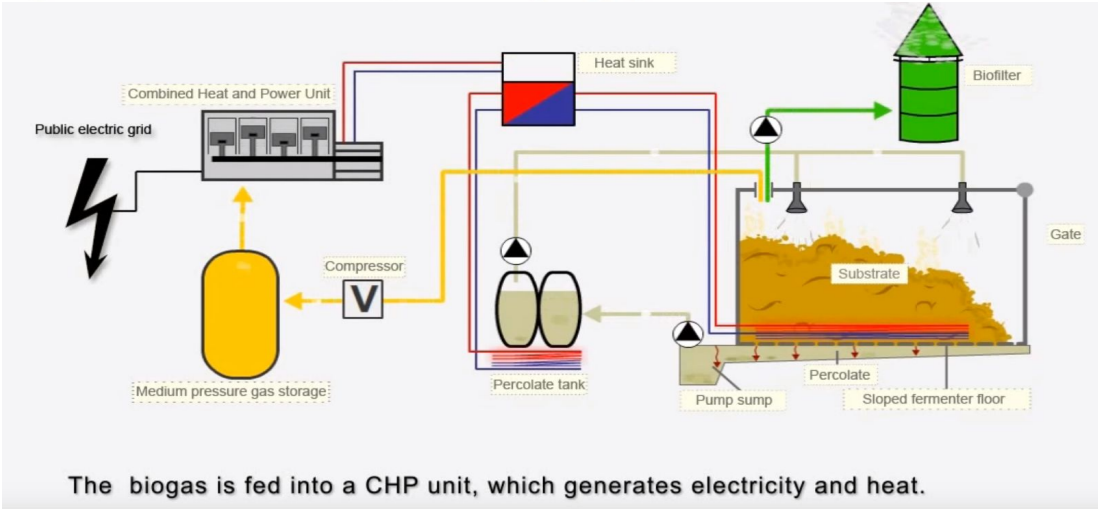
Akademisk avhandling för avläggande av teknologie doktorsexamen vid Lunds Universitets tekniska fakultet. Avhandlingen kommer att offentligen försvaras fredagen den 31 augusti kl 13.30 på Kemicentrum, Hörsal B, Sölvegatan 39, Lund.

Academic thesis, which by due permission of the Faculty of Engineering at Lund University, will be publicly defended on Friday August 31 at 1:30 p.m., at the Center for Chemistry and Chemical Engineering, Sölvegatan 39, Lund, for the degree of Doctor of Philosophy in Engineering.

The Faculty opponent is Univ. Prof. Dipl.-Ing. Dr. Andreas Gronauer, Institute of Agricultural Engineering, Department of Sustainable Agricultural Systems, University of Natural Resources and Life Sciences, Vienna.



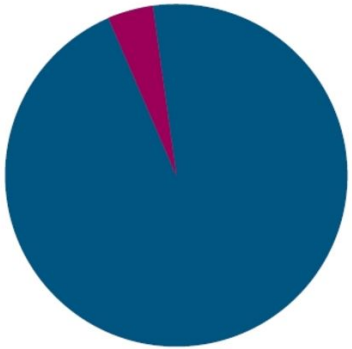
Layout of EcoVolt solution at Bear Republic Brewing Company.

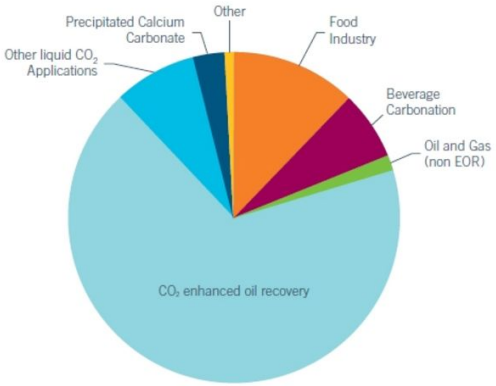


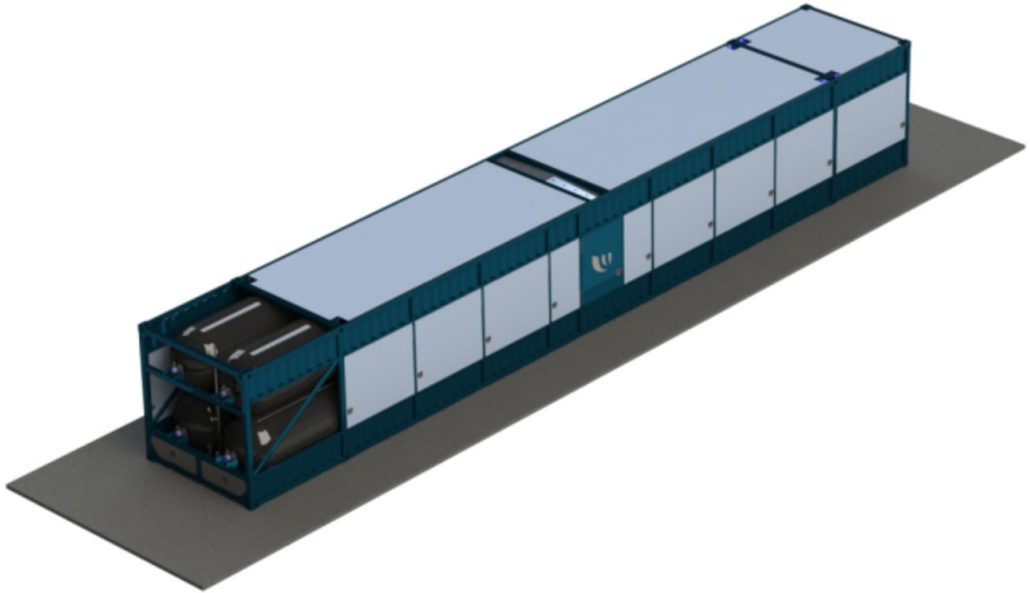
The biogas is fed into a CHP unit, which generates electricity and heat.

CCS

Carbon Capture and Storage







Carbon Neutral

It's time to Develop Carbon Labeling

how else will consumers vote with their pocketbooks?