



# Developing sustainable urban/vertical farms: Insights from life cycle-based methods



Michael Martin  
Senior Researcher-IVL Swedish Environmental Research Institute  
Researcher- KTH Royal Institute of Technology

# Vertical/Urban Farming

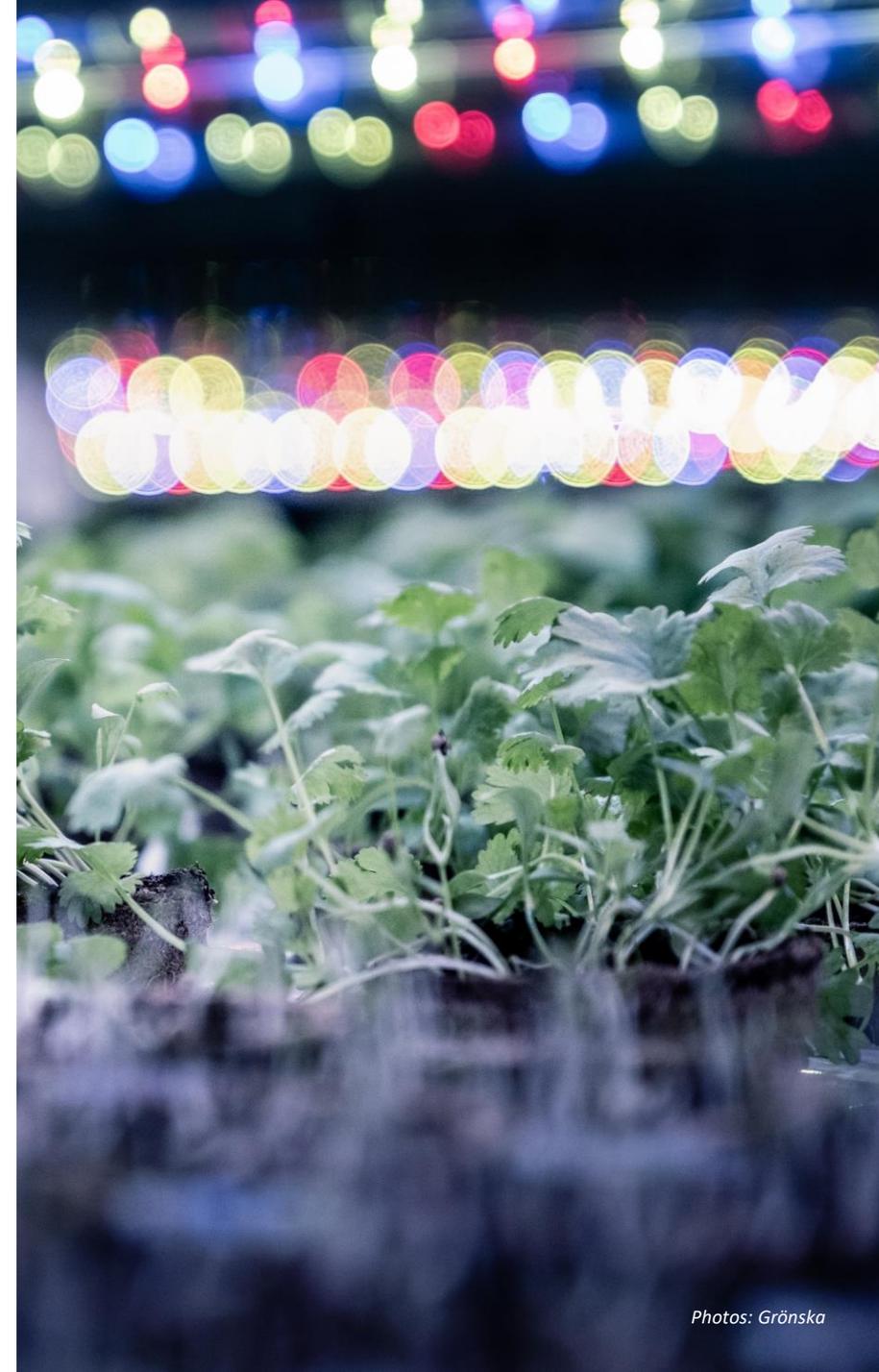
- Growing in layers to increase productive area
- Hydroponic/Aeroponic/Aquaponic systems
- Different Sizes/Configurations:
  - Plant Factories
  - Modular/Hyper-Local Systems
- Typically with LEDs as lighting source
- With/Without Soil
- Typically producing leafy greens and herbs
  - Can be expanded and integrated with other products
  - Gen 1-Gen 2 and Aquaponic, etc.



# The Expectations and Discourse Employed...

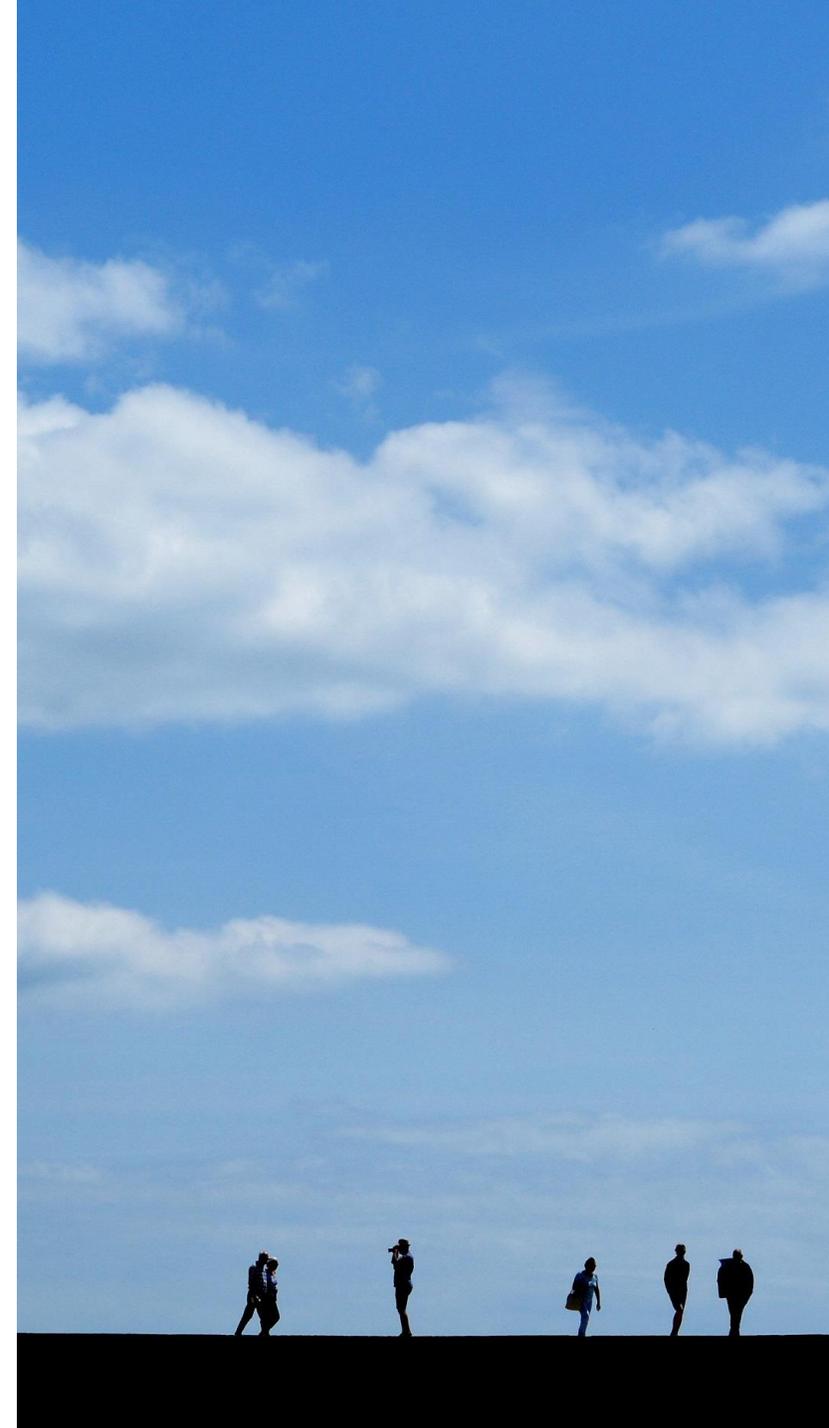
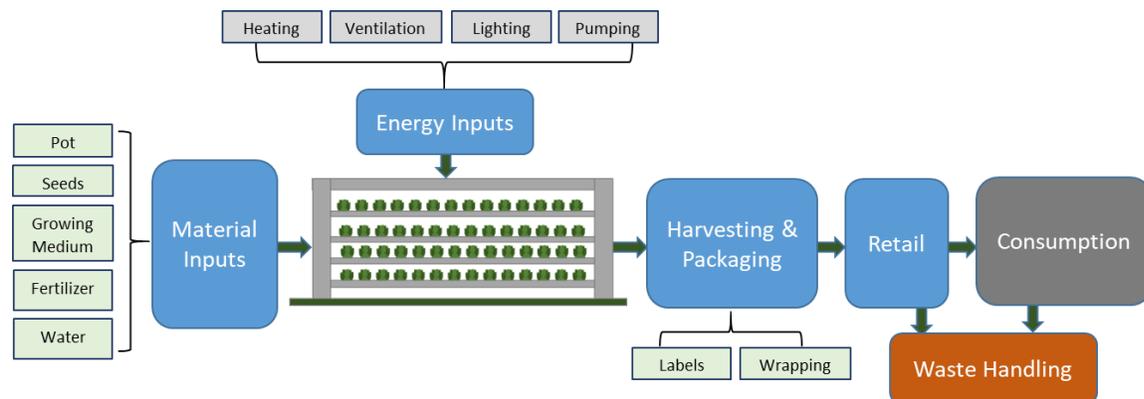
- Often focused on *sustainability*
- Self-sufficient urban areas
- *Reduced* transportation and water consumption
- *Improved* yields per area
- *Resource-efficient* methods
- Shorter supply chains
- Large potential for expansion
- Recently, packaging in focus...

***This often leads to criticism of their systems...***



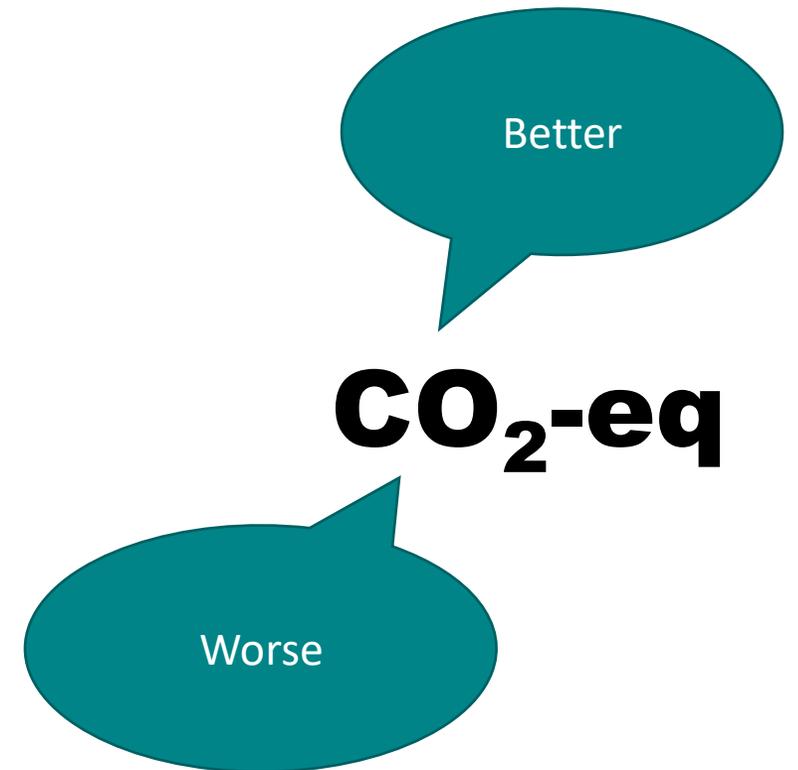
# Applying Life Cycle-Based Methods (LCA)

- **Where**-do the impacts/benefits occur?
- **How**-can we reduce/improve these?
- **What**-available materials, utilities, systems and technologies can be used?
- **Who**-can support the transition?



# Use and Misuse of Life Cycle Perspective

- Some claims may be unsubstantiated
- Comparative Assertions to other crops, systems, services
- Staying Objective/Transparent through Life Cycle-Based Methods
- Large number of critics
- Important to add Validity/Legitimacy
- Rapidly expanding subject of inquiry, new methods, data and indicators being developed



# What do we know about their sustainability?

- Few articles available
  - Tend to focus on potential
  - Few case studies
  - Divergent system scopes worldwide/context dependent
- Few companies with transparent data/information
  - Not wanting to be the 'first'
- Many carbon assessments, but few tackle other indicators
  - (e.g. Socio-Economic benefits, Economic performance)



# Challenges from an LCA perspective

- Emerging/Evolving systems which constantly improve and progress
  - Attributional (Snap-shot) or Prospective (Future)?
  - Changes in Systems/Data Availability (Optimization/AI)
- Energy Demand
  - LEDs and Ventilation
  - Timing (Photoperiod, Emissions Profile for Mix)
  - Attributional or Consequential Modeling
- Functional Unit of the Systems
  - Plants (potted (pots), harvested (kg)), Annual Production?
  - Nutrition, Quality ?



# Challenges from an LCA perspective (Continued)

- Market and Distribution
  - Logistics/Fuel
- Packaging
  - Material Choice (Properties, Shelf-Life, Quality)
  - End-of-Life Treatment (Packaging, Growing media)
- Avoiding Comparative Assertions
  - Comparing to conventional farms
  - Requires Standards/methods to make claims/assertions
- LCI data for these systems
  - Limited availability of food/agriculture related inputs
- Expanding the discourse/rhetoric used
- **Include other indicators to show the value for local food systems and markets and economic viability**



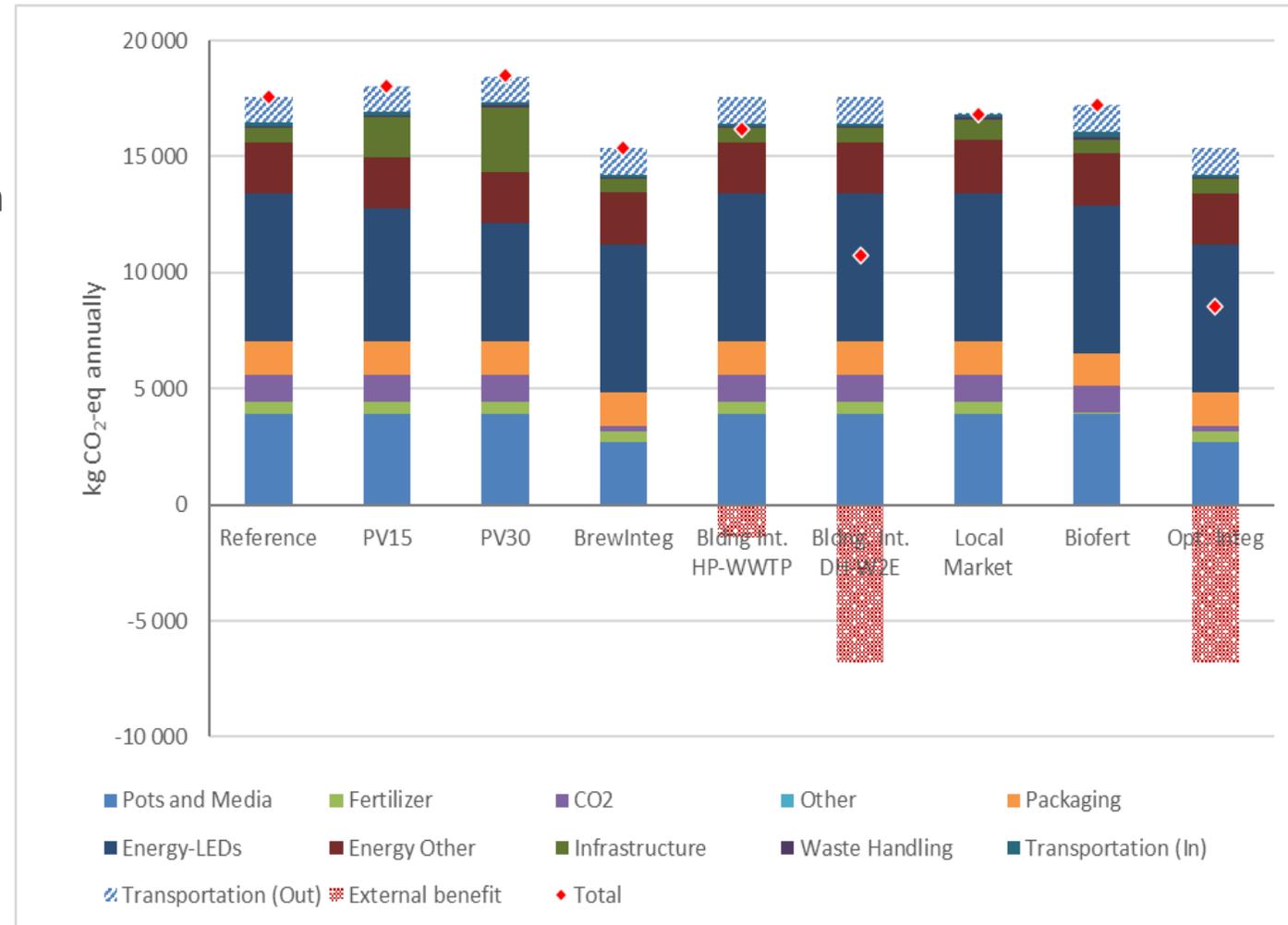
# Environmental Performance Improvements

- Optimization of Energy Use
- 'Greener' Electricity
- Choice of Pots (Material)
- Growing Media/Fertilizers
- Transportation/Logistics
  
- *Connecting to urban/peri-urban infrastructure/systems*



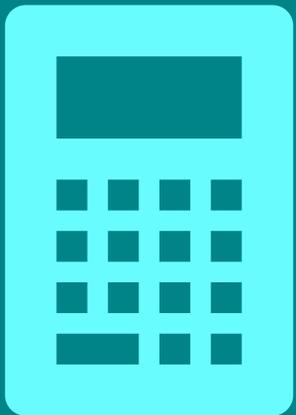
# Urban Symbiosis: Urban Vertical Farming

- Employing urban residual streams in urban farming systems
- Unused/residual space
- Urban compost, recycled paper and brewing spent grains as growing medium
- Urban food waste-biogas-biofertilizers
- Mushroom Production, etc.
- Reduced waste handling
- Integration with building/energy systems
- Resilient food systems
- Intra-regional/urban symbiosis
  - Employ Building Level and Urban Symbiosis



Most companies worked with have replaced conventional growing media, taken more considerations for circular nutrient solutions, and making progress toward reducing energy demand

# Environmental sustainability: Only one piece of the puzzle



# Conclusions

- **Sustainability is a process**
- Developing systems and potential
- Context dependent
- Transparent/sound assessments
- Link to urban/peri-urban systems
  - Residual-urban materials
  - Urban infrastructure and energy systems
- **Have fun and be creative!**

# Some interesting reading/viewing material:

- Chance, E., Ashton, W., Pereira, J., Mulrow, J., Norberto, J., Derrible, S. and Guilbert, S. (2018), The Plant—An experiment in urban food sustainability. *Environ. Prog. Sustainable Energy*, 37: 82-90. <https://doi.org/10.1002/ep.12712>
- Martin, M. and Harris, S. (2018). Prospecting the sustainability implications of an emerging industrial symbiosis network. *Resources, Conservation & Recycling* 138, pages 246–256. <https://doi.org/10.1016/j.resconrec.2018.07.026>
- Martin, M. Are vertical farms sustainable? ISHS Vertical Farm Talks: <https://vimeo.com/555790269>

# Thank You

[michael.martin@ivl.se](mailto:michael.martin@ivl.se)