Sustainability of Very Large Photovoltaic Deployment

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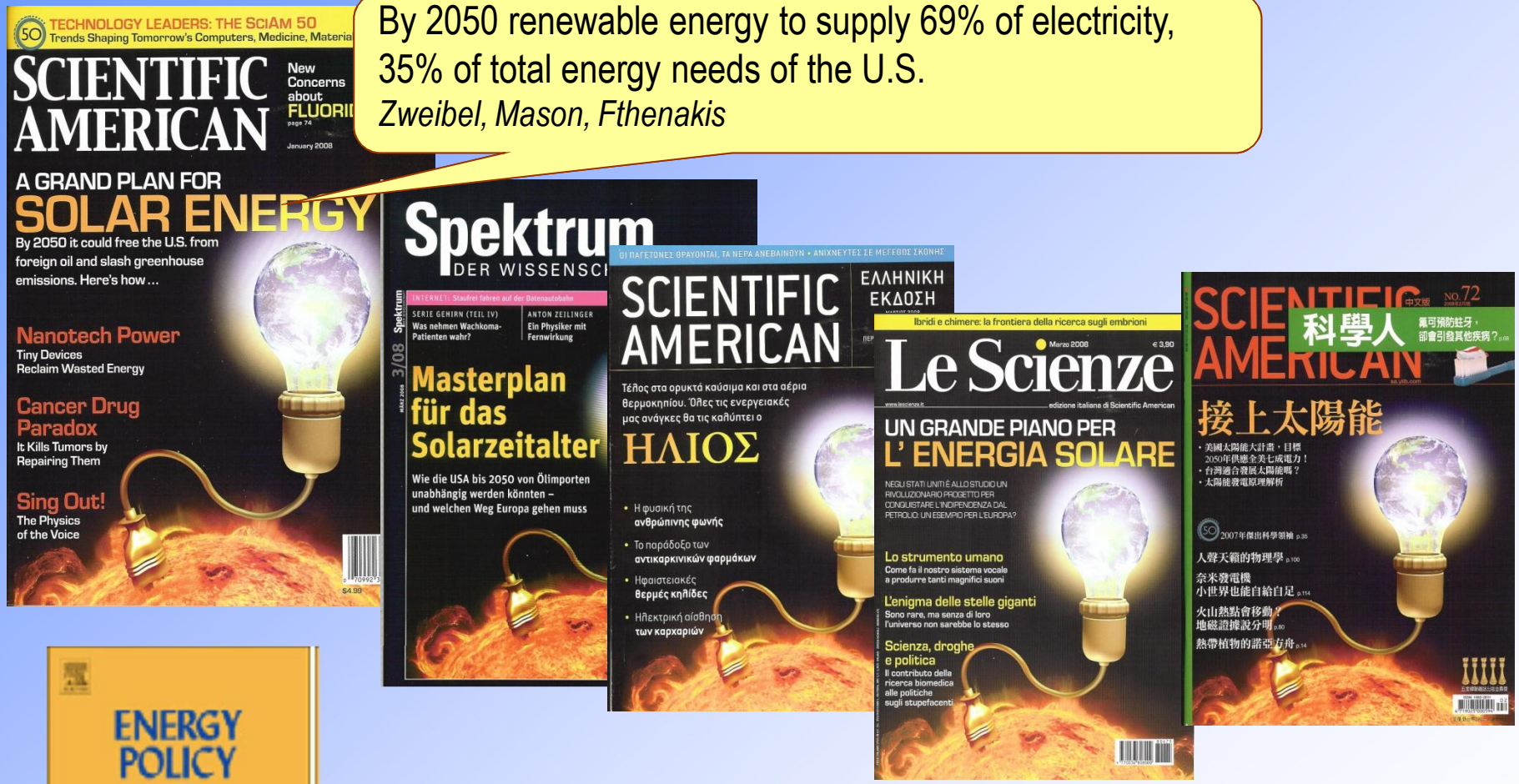
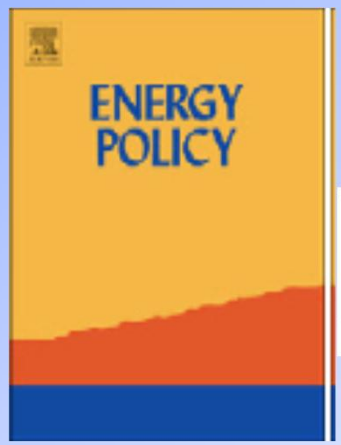
A Solar Grand Plan

By 2050 renewable energy to supply 69% of electricity, 35% of total energy needs of the U.S.
Zweibel, Mason, Fthenakis



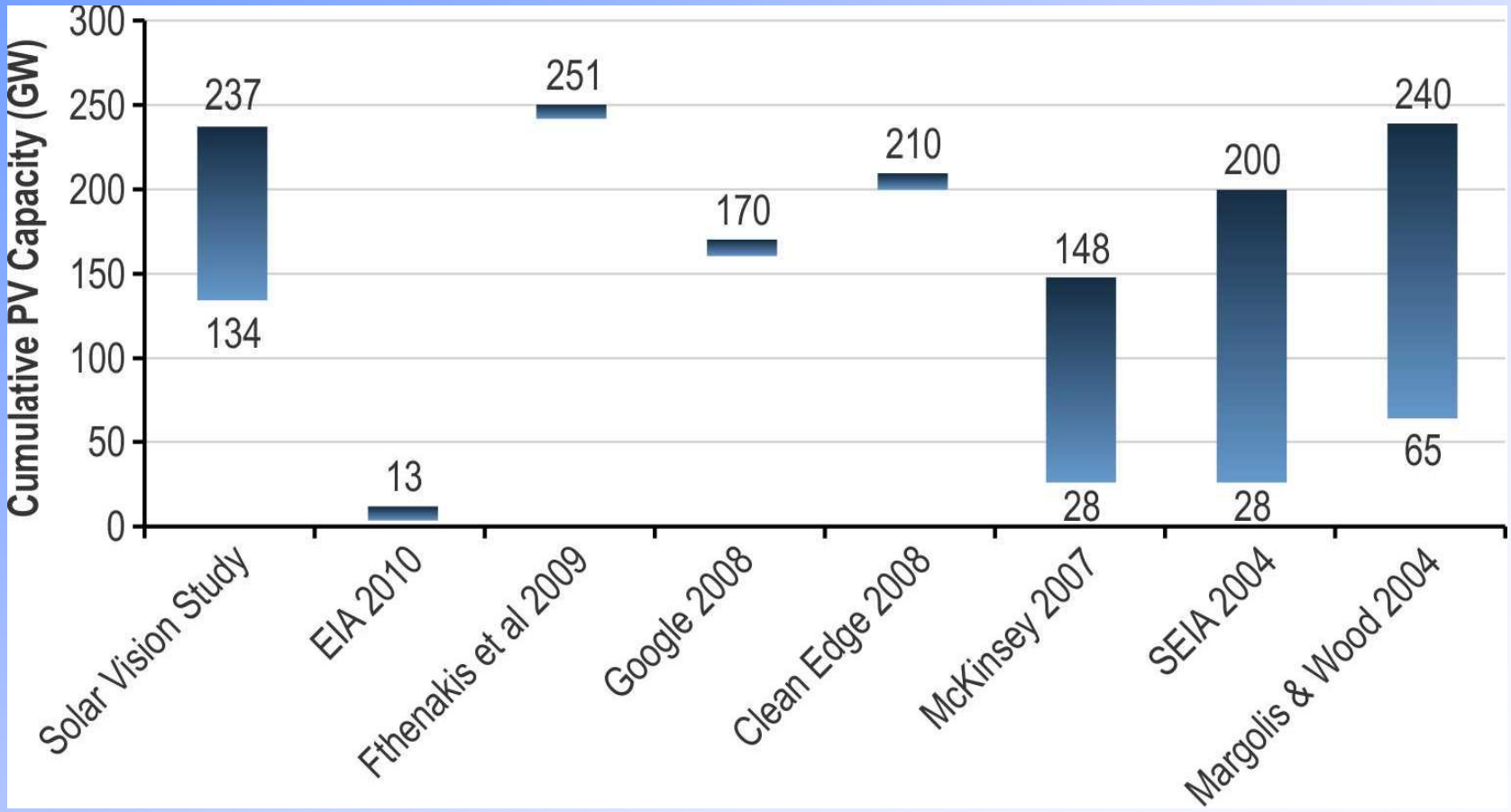


The technical, geographical, and economic feasibility for solar energy to supply the energy needs of the US

Vasilis Fthenakis James E. Mason Ken Zweibel

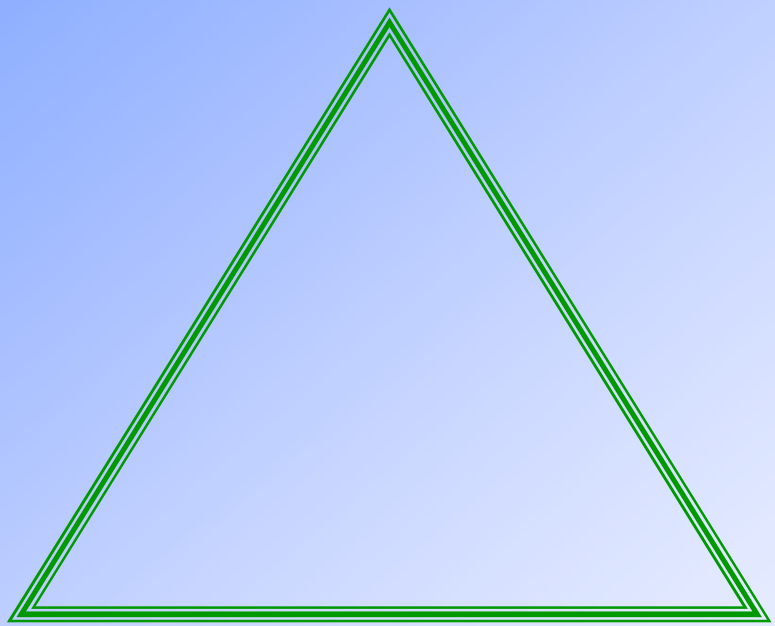
Energy Policy 37 (2009)

PV Capacity Projections: United States 2030



DOE-EERE Solar Vision Study Report is in review, not to be cited

PV –Sustainability Criteria



Affordability in a competitive world

Low Cost

Life Cycle Analysis
Recycling
Risk Analysis

Lowest Environmental Impact

Resource Availability

Te in CdTe
In in CIGS
Ge in a-SiGe & III/V
Ag in c-Si

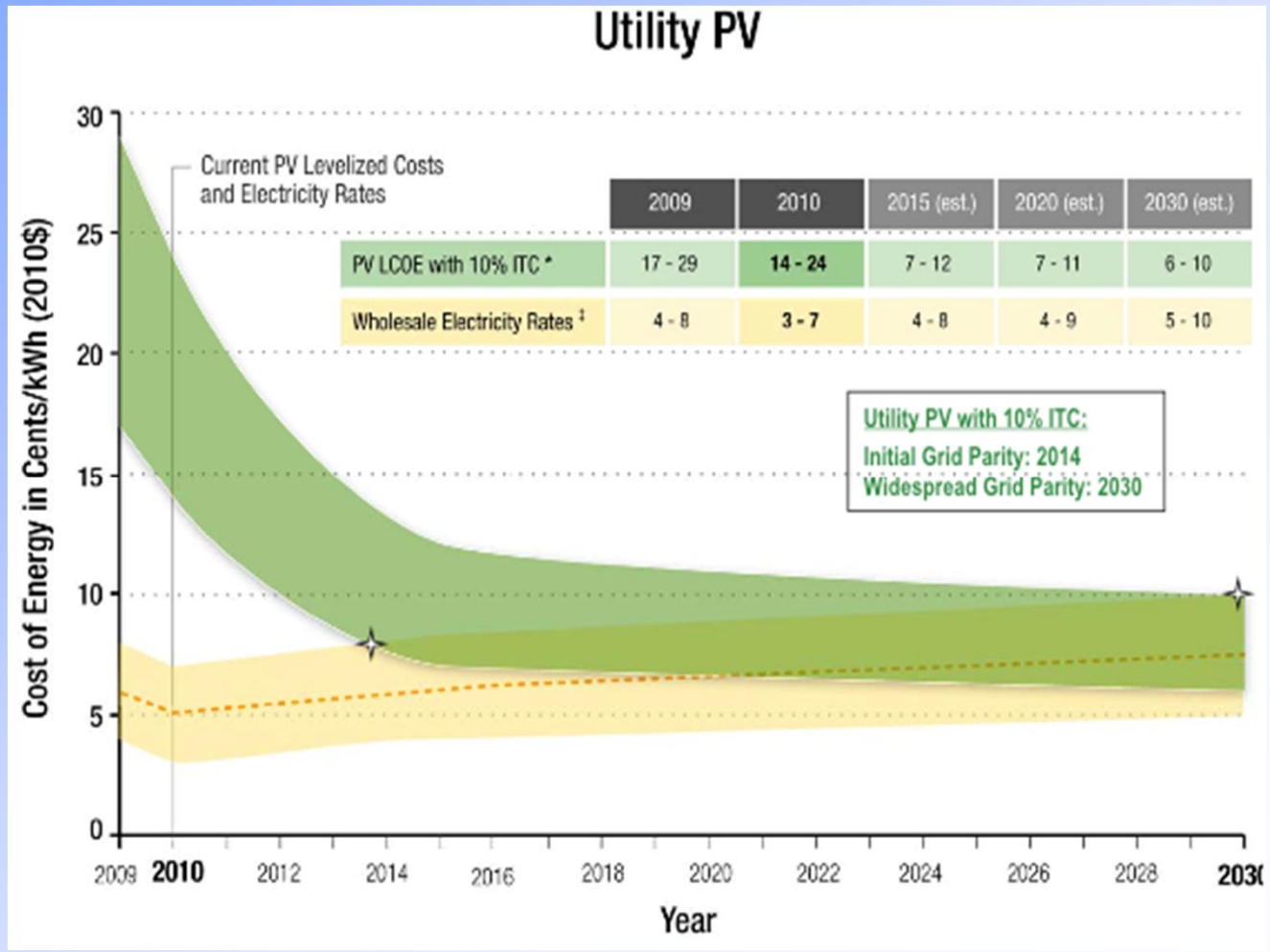
Affordability: Projected PV Growth and Electricity Price Targets

Geographic Locations

Phoenix, AZ
Kansas City, MO
New York, NY

Financing Conditions

Low: 8.2%
High: 9.9%



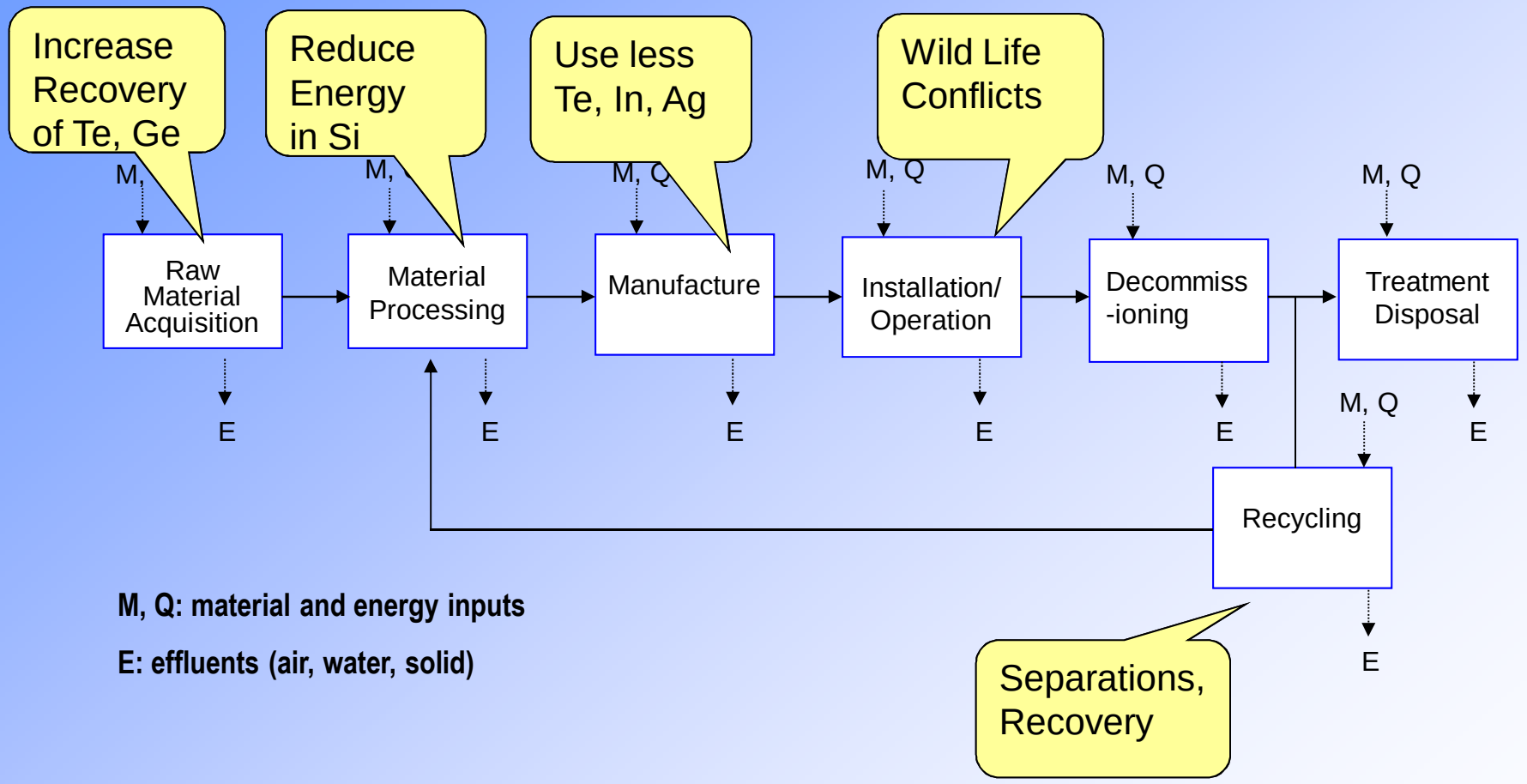
Source: J. Lushetsky, Solar Technologies Program, US-DOE, 25th EUPV, Valencia, Spain, Sept. 2010

Material Use and Recovey: Research Areas

- Increase of Te recovery from Cu smelters
- Increase of Ge and In recovery from Zn smelters
- Thinner layers of thin-film materials (CdTe, CIGS)
- Increased module efficiencies
- Si wafer-based cells designs using less Ag
- Recycling

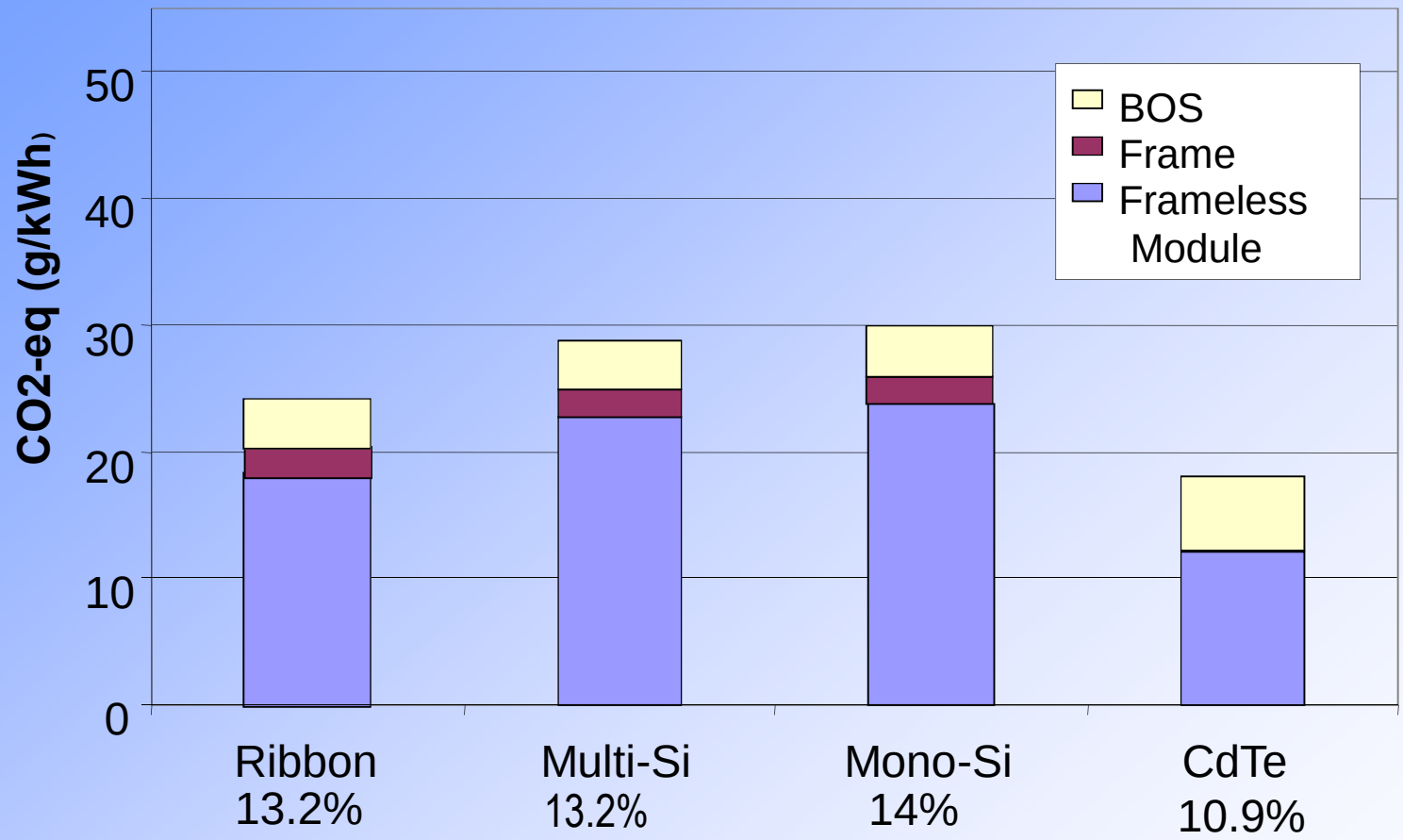
Life Cycle Environmental Impacts

Example Research Areas



Greenhouse Gas (GHG) Emissions

Insolation: 1700 kWh/m2-yr



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- **deWild 2009**, *EUPV, 2009*
- ***Fthenakis et al.,*** *EUPV, 2009*
- **Fthenakis & Kim,** *ES&T, 42, 2168, 2008*
- **Alsema & de Wild,** *Material Research Society, Symposium, 895, 73, 2006*
- **deWild & Alsema,** *Material Research Society, Symposium, 895, 59, 2006*
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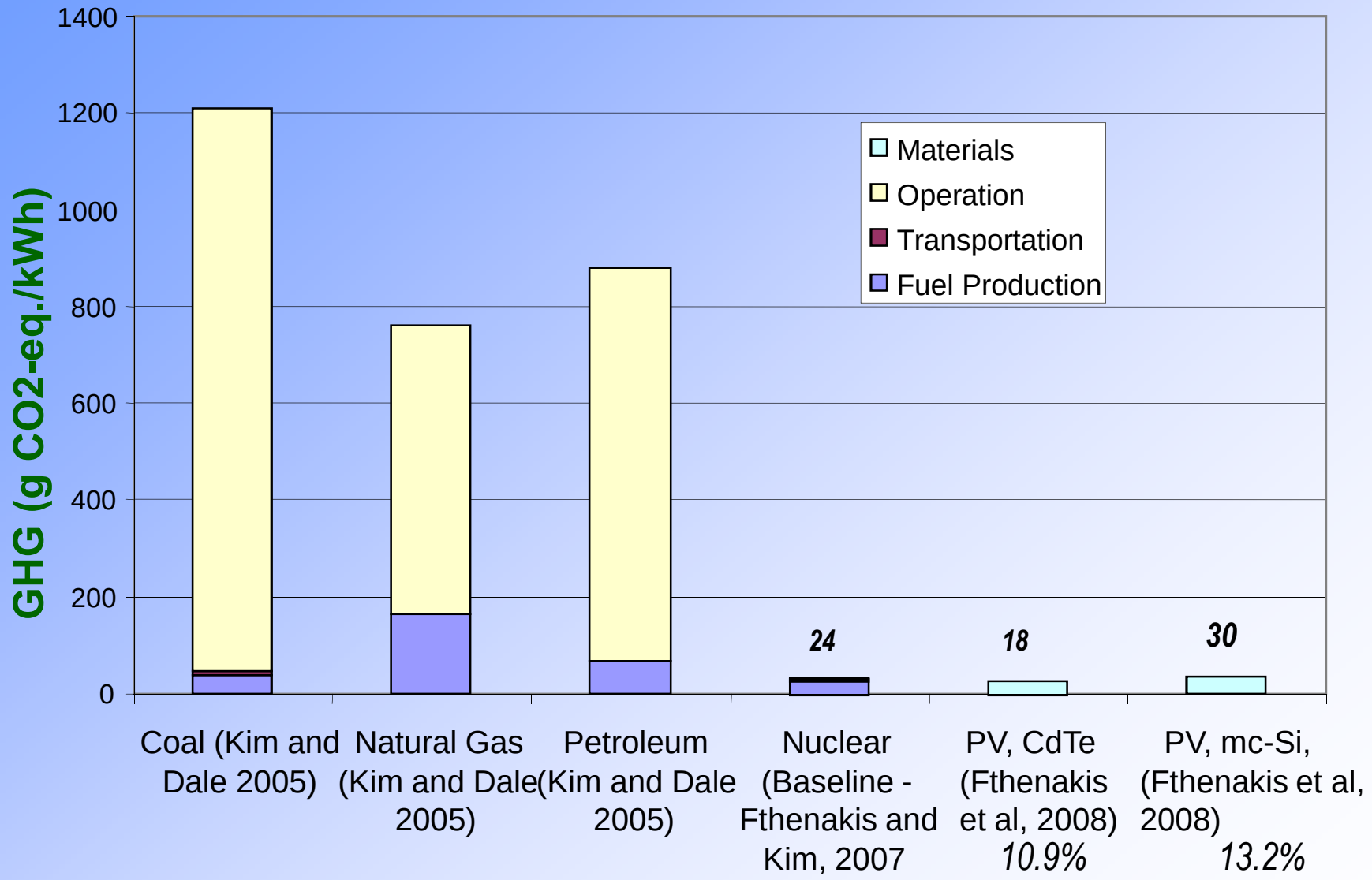
- **Fthenakis & Alsema,** *Progress in Photovoltaics, 14, 275, 2006*

GHG Emissions from Life Cycle of Electricity Production: Comparisons



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Fthenakis & Kim, Life Cycle Emissions…, *Energy Policy, 35, 2549, 2007*
Fthenakis & Kim, *ES&T, 42, 2168, 2008*

LCA Research Topics

- Resource Use (materials, water, land)
- Energy Use
  - Si Production
- EH&S Risks
- Biodiversity Conflicts
- 3rd Generation PV Technologies
- Full Cost Accounting of Electricity Generation

Zero impact technology does not exist ➔

Compare with other energy producing technologies as benchmarks

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