Sustainable & Productive: Improving Incentives for Quality Software

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A Few Terms

Reproducible
Real result, not coincidence or mistake.

Productive
Better, Faster, Cheaper: Pick all three

Sustainable
Code usable for expected SW lifetime

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Impediments To Change

Common statement: "I would love to do a better job producing quality software, but I need to:

> Get this paper submitted.

> Complete this project task.

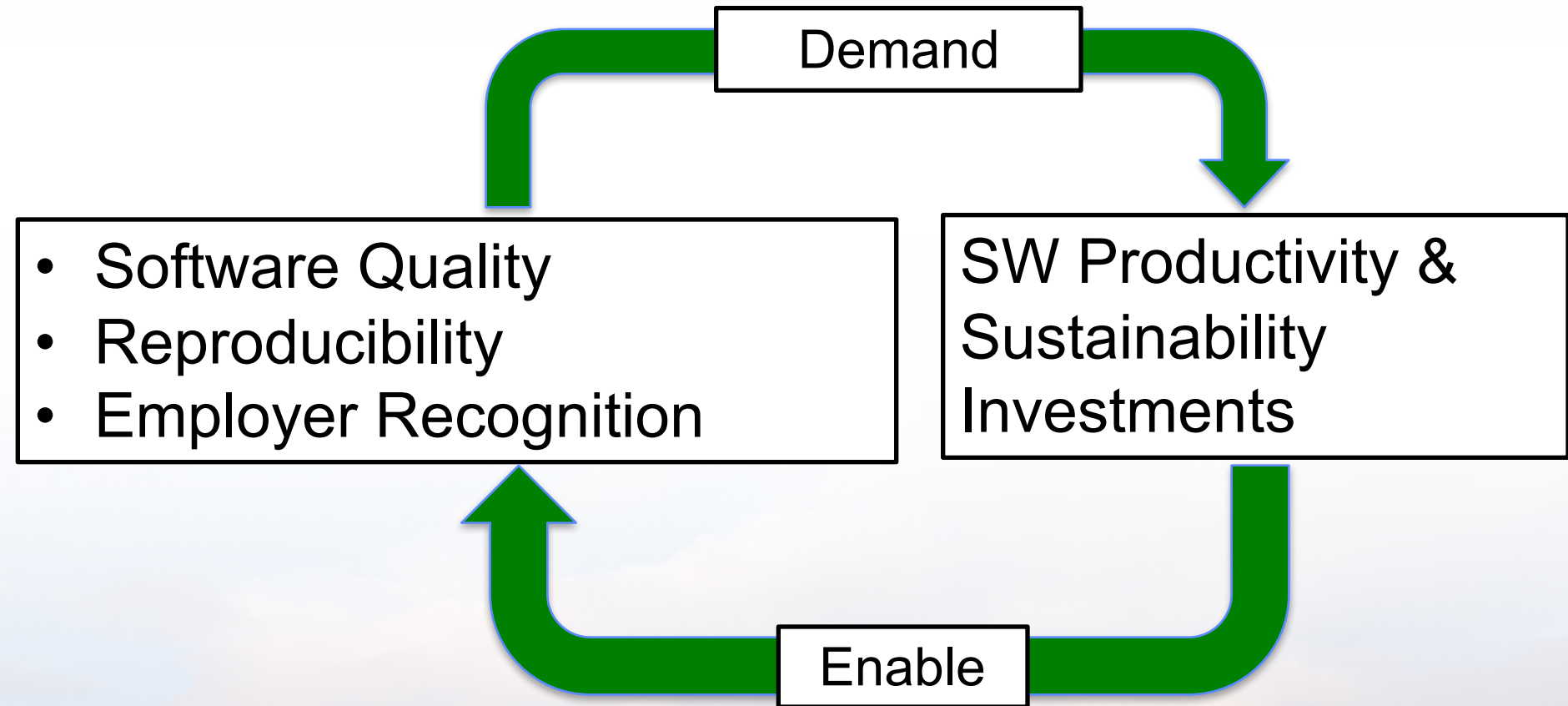> Do something my employer values more.

Need to change incentives: Include value of better software.

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How the Future will be Different

- Publishers:
  - Will expect reproducible computational results.
- Funding agencies:
  - Will expect improved productivity, sustainable software.
- Employers:
  - Will reward staff, faculty producing good software.

- Impact:
  - Scientific software will be more effective.

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Incentives To Change

Demand

- Software Quality
- Reproducibility
- Employer Recognition

SW Productivity & Sustainability Investments

Enable

Funding Agencies: SW Quality

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                    ┌─── Demand ───┐
                    │              ▼
┌──────────────────────┐   ┌──────────────────────┐
│ • SW Quality          │   │ SW Productivity &    │
│   Requirements        │   │ Sustainability       │
│ • Reproducibility     │   │ Investments          │
│ • Employer Recognition│   │                      │
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- *SW Quality Requirements*
- Reproducibility
- Employer Recognition

Demand

SW Productivity & Sustainability Investments

Enable
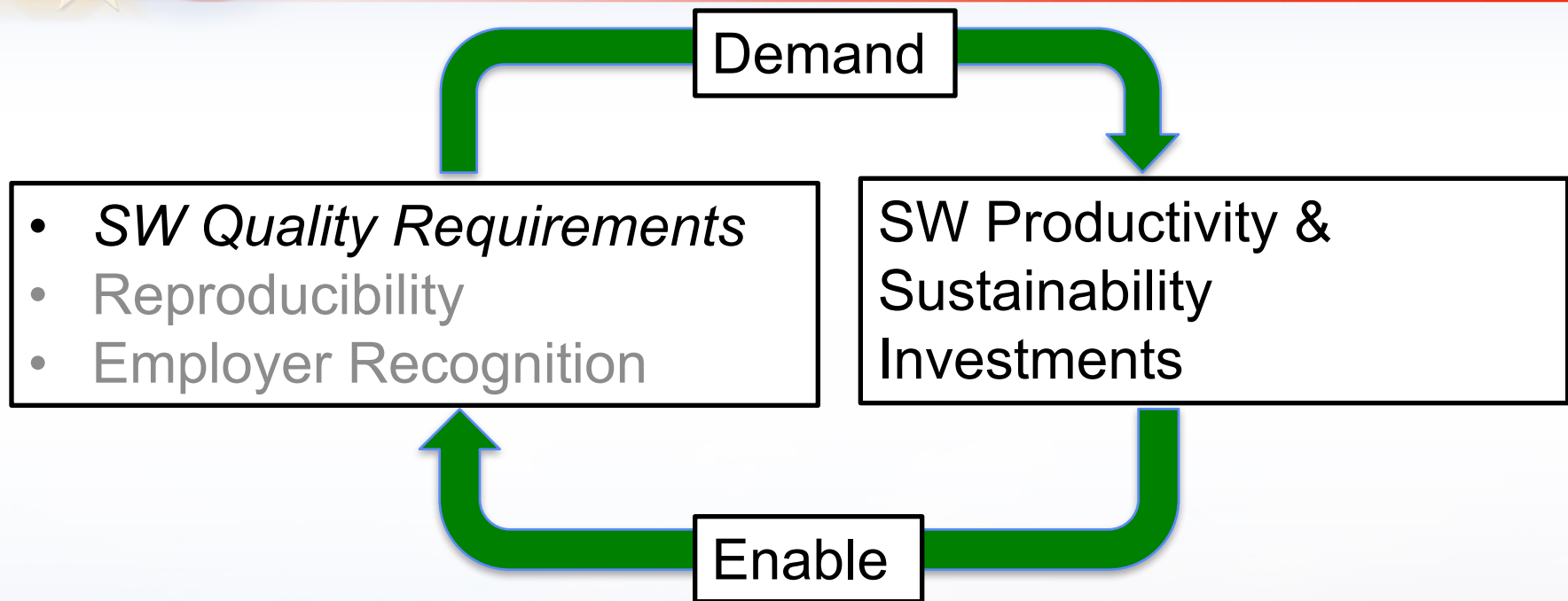
Key Idea: Funding agencies can request information and evidence of key software quality commitments and activities.

Example: SW Productivity & Sustainability Plan

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DOE SW Productivity and Sustainability Plan (SW PSP).

- Key Entities:
    - DOE Biological and Environmental Research (BER).
    - DOE Advanced Scientific Computing Research (ASCR)
    - IDEAS Scientific SW Productivity Project
- Milestone:
    - First-of-a-kind SW Productivity and Sustainability Plan.
    - *Two 2016 DOE Funding Opportunity Announcements included a SW PSP*

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- Describe overall SW development process.
  - Software lifecycle, testing, documentation and training.
- Development tools and processes:
  - source management, issue tracking, regression testing, SW distribution.
- Training and transition:
  - New and departing team members.
- Continuous process improvement:
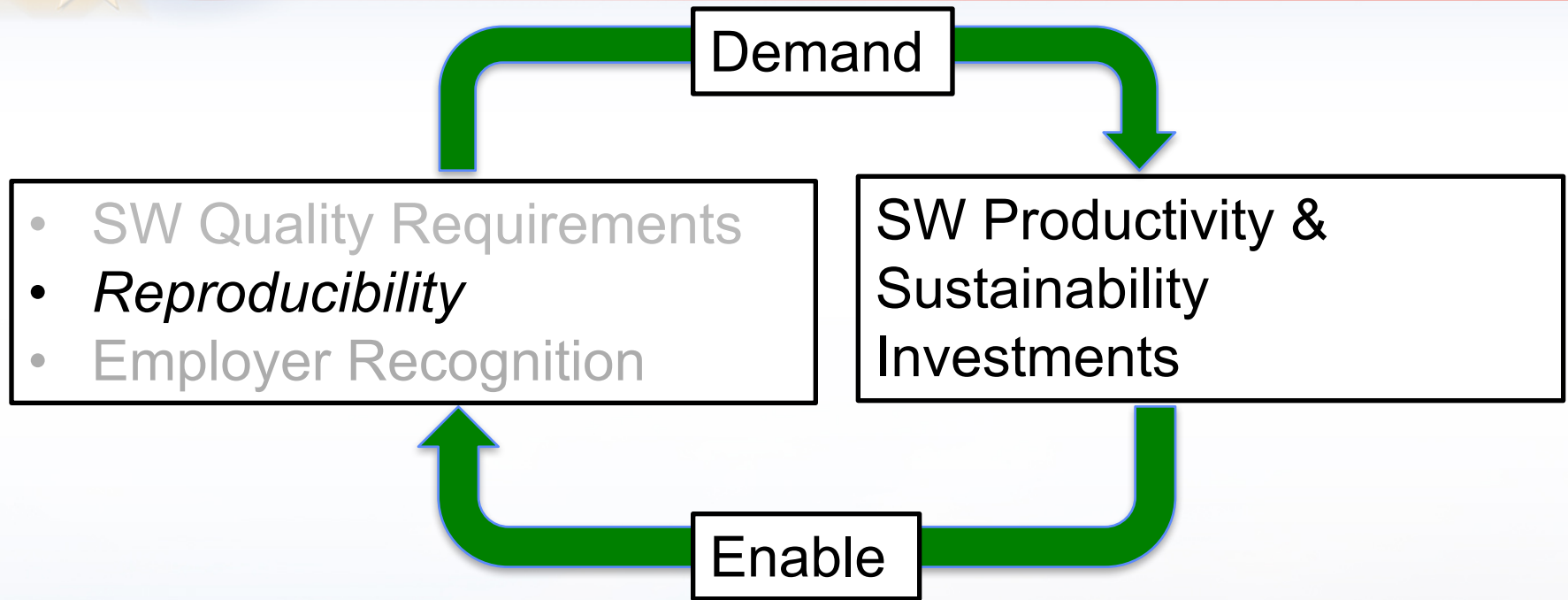 - Getting better at productivity and sustainability.

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Be prepared to have funding tied to evidence of good software practices.

Invest in best practices, tools, training; always improve.

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Publishers: Reproducibility

Demand

- SW Quality Requirements
- *Reproducibility*
- Employer Recognition

SW Productivity & Sustainability Investments

Enable

Key Idea: Publishers can expect reproducible results.

Example: ACM Replicated Computational Results

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ACM TOMS Replicated Computational Results (RCR)

- Submission: Optional RCR option.
- Standard reviewer assignment: Nothing changes.
- RCR reviewer assignment:
  - Concurrent with standard reviews.
  - As early as possible in review process.
  - Known to and works with authors during the RCR process.
- RCR process:
  - Multi-faceted approach, Bottom line: Trust the reviewer.
- Publication:
  - Replicated Computational Results Designation.
  - The RCR referee acknowledged.
  - Review report appears with published manuscript.

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Reproducibility Status & (Some) Futures

- TOMACS: Adopted TOMS RCR.
- ACM: Completed electronic workflow support, badging.
- Conference proceedings:
  - PPoPP, other conferences, reviewing artifacts.
  - SC16, 17 and beyond. Progressive increase of results review.
- AAAS:
  - *Science* paper (from 3rd Arnold Workshop on Reproducibile Science):
    - *The "REP" Standards for Disclosing Computational Methods*
      Victoria Stodden, Marcia McNutt, David H. Bailey, Ewa Deelman, Yolanda Gil, Brooks Hanson, Michael A. Heroux, John P.A. Ioannidis, Michela Taufer*, submitted, July 2016.*
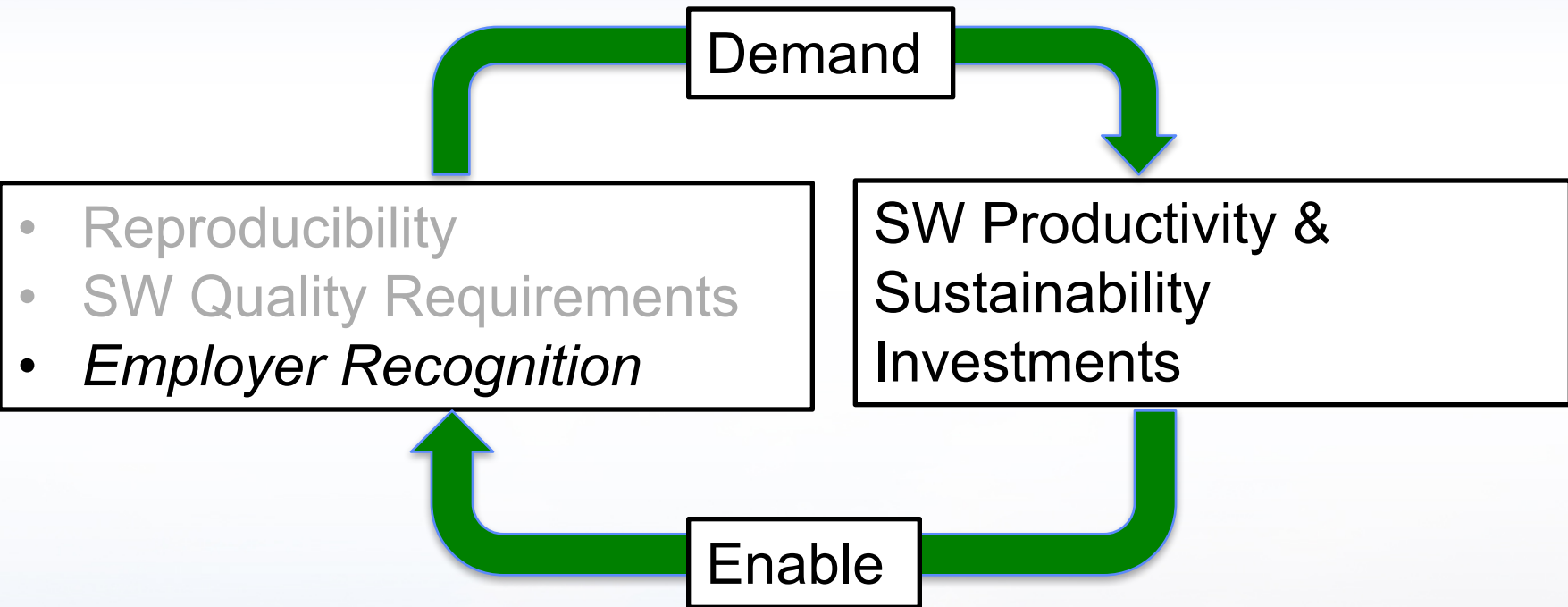   - REP = Reproducibility Enhancement Principles

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Be prepared to have someone else replicate your results.

Create, retain artifacts that establish credible results.

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Employers: Recognition

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                    ┌─ Demand ─┐
                    │          ▼
┌──────────────────────┐   ┌──────────────────────┐
│ • Reproducibility    │   │ SW Productivity &    │
│ • SW Quality         │   │ Sustainability       │
│   Requirements       │   │ Investments          │
│ • Employer           │   │                      │
│   Recognition        │   │                      │
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Next focus:

- Work with labs, universities, industry to recognize SW contributions as first class contributions.

- Promote funding for R&D in scientific software productivity.

Advocate for the value of high quality software in your life:

- *Cite software.*

- *Promote with your management.*

- *Evaluate SW quality in reviews.*

- *Promote the need for SW productivity research.*

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Summary

- Good intentions of scientific teams is not sufficient for improving software quality.
- Software quality will be calibrated to meet the expectations of:
  - Funding agencies.
  - Publishers.
  - Employers.
- Improving software quality requires increasing rewards for:
  - Software practices, processes, tools,
  - Reproducible published results.
  - Employee recognition.

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