

# Using Competitions to Accelerate the Development of Grid Optimization Breakthroughs

**Tim Heidel**

Program Director

Advanced Research Projects Agency – Energy (ARPA-E)

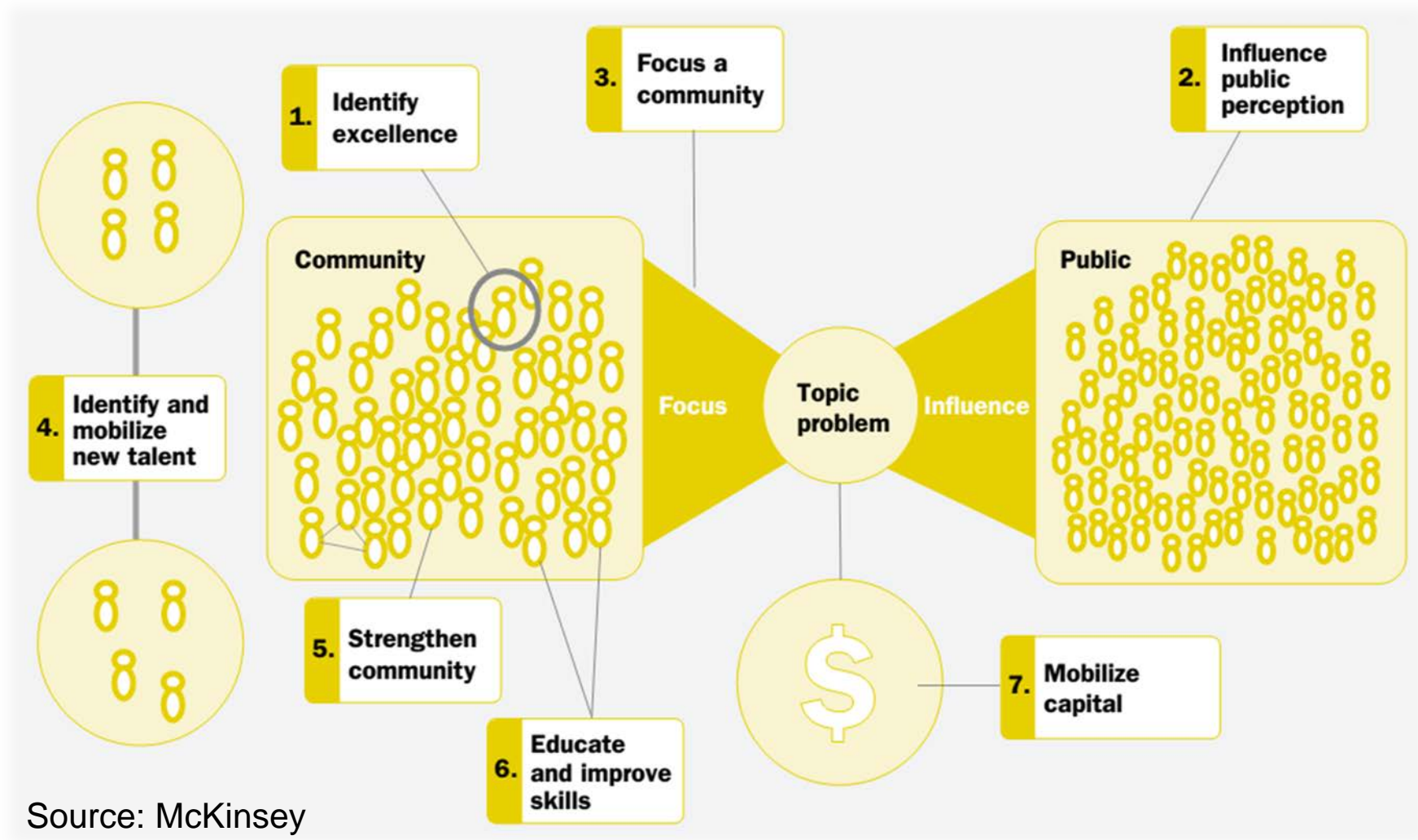
U.S. Department of Energy

**ARPA-E Energy Innovation Summit**  
**Washington, DC March 1, 2016**



U.S. DEPARTMENT OF  
**ENERGY**

# Prize Contests

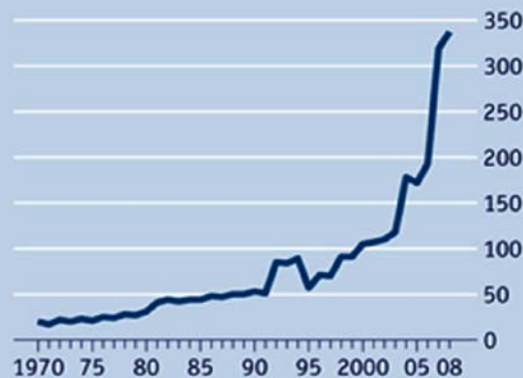


# Competition Success Stories



## The rise of the prize

Worldwide prizes worth \$100,000 or more, \$m



Found 10 balloons across  
U.S. in under 9 hours



Leustagos	0.145	0.138
DuckTile	0.143	0.145
MZ	0.141	0.151
Propeller	0.144	0.153
Duehee Lee	0.157	0.144
MTU EE5260 forecast team	0.161	0.172
SunWii	0.174	0.177
ymzmsid	0.163	0.186
413	0.179	0.179
Benchmark	0.202	0.338

IEEE "Global Energy  
Forecasting Competition"  
60% forecast error  
reduction  
Winners from 8 different  
countries (2012)



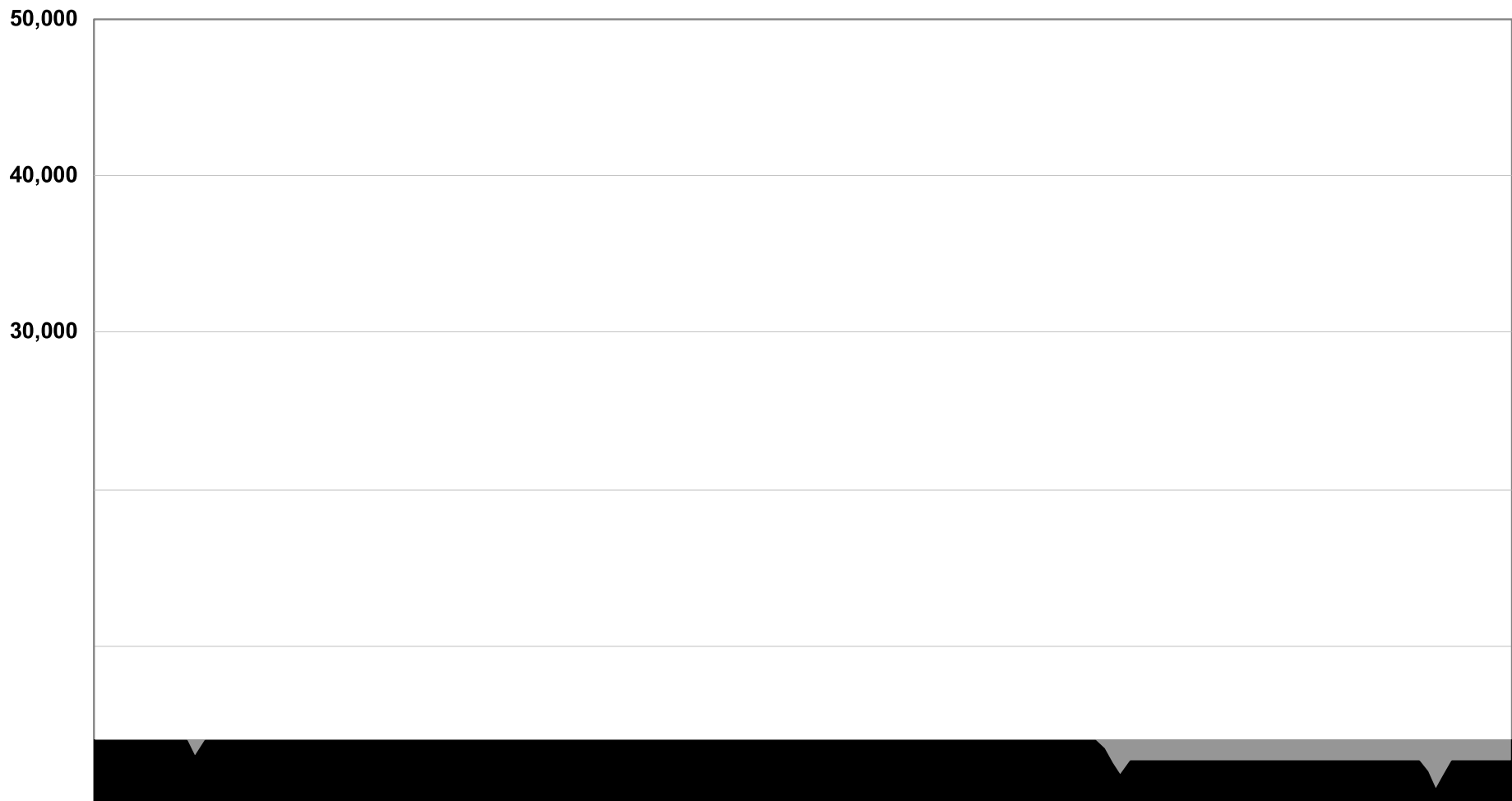




Source: Robert Simmon, NASA Earth Observatory







Source: DOE Western Wind and Solar Integration Study (2011)





MICHIGAN STATE  
UNIVERSITY

**13.8 KV, 2 MVA PROTOTYPE**  
**INVERTER MODULES** { 12 SERIES  
30 SHUNT



OAK  
RIDGE  
National Laboratory

**115kV, 1500A Prototype (2-5  $\Omega$ )**  
**Continuously Variable Series Reactor**

SMART  WIRES  
REIMAGINE THE GRID

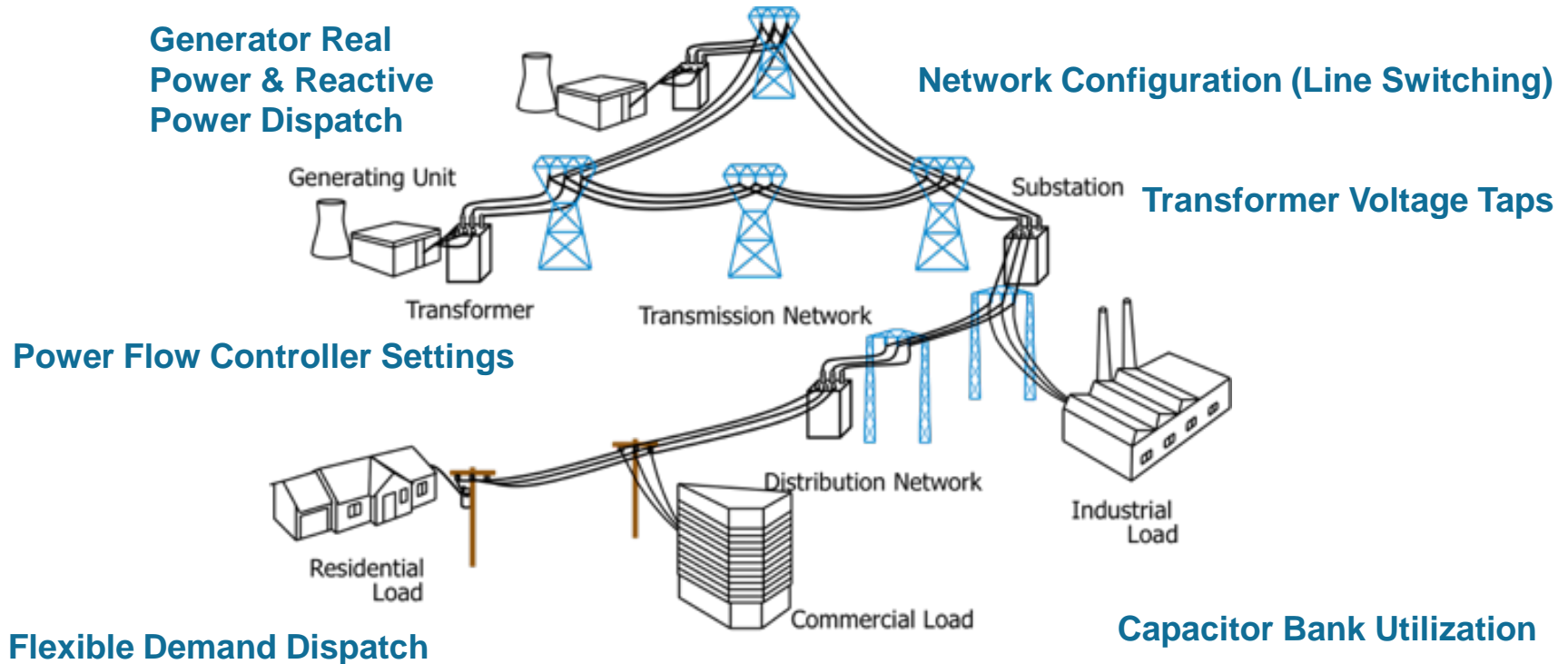
**50uH (<150 lbs) Prototype**  
**Distributed Series Reactor**





# New Optimal Power Flow Methods Needed

- ▶ Optimizing grid power flows (subject to the physical constraints) is an extremely challenging optimization problem.
- ▶ New solution methods could offer substantial (5-10%) cost savings and help facilitate full utilization of high penetrations of renewable generation.



# Algorithm Competition Requirements

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## 1. Realistic, challenging benchmarking models/datasets

### 1. Detailed, accessible problem definition

- Sufficiently complex to be industrially relevant and valuable but accessible to non-domain experts
- Clear objective(s) and desired solution characteristics
- Consistent, clear modeling assumptions (consistent with industry needs)
- Transparent, quantitative scoring criteria

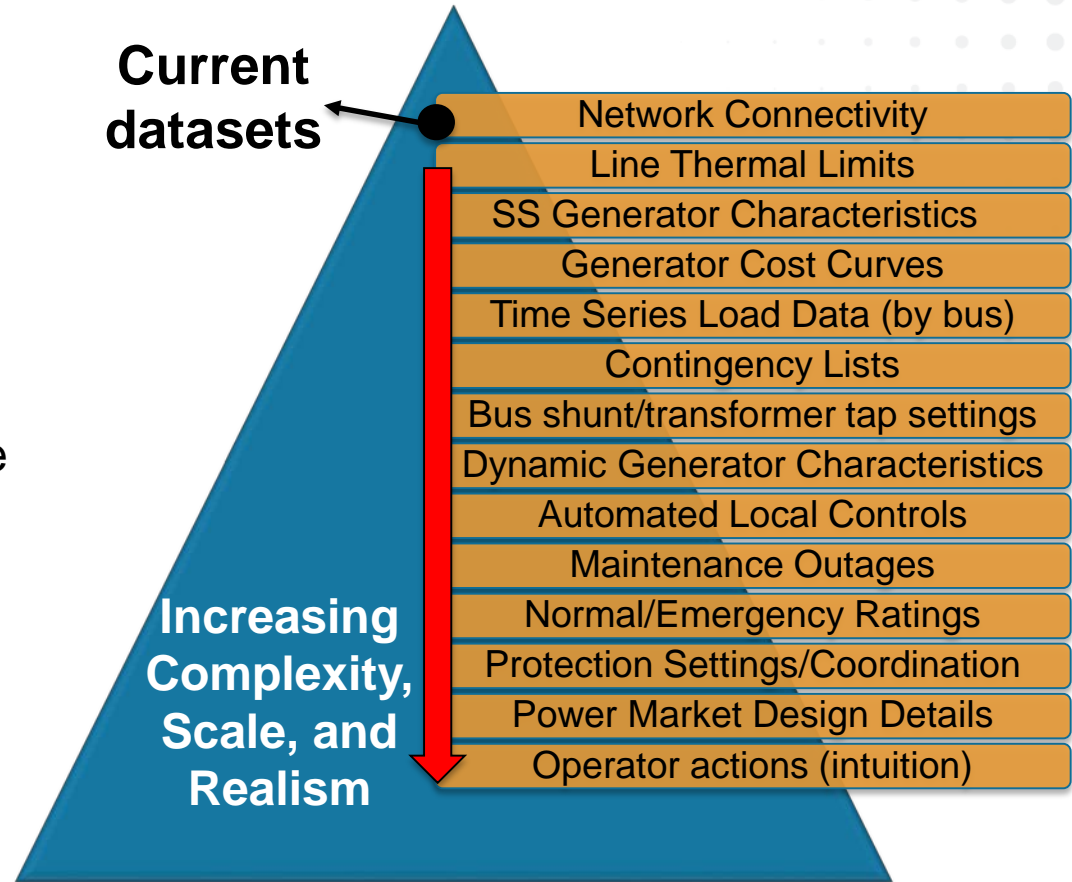
### 2. Fair solution method evaluation platform or method

- Automated evaluation and scoring of solution methods using a consistent, carefully instrumented computational platform.
- Separation of training and competition datasets
- Public leaderboard to promote active participation

# Need Large-scale, Realistic, Validated, Open-Access Power System OPF Datasets/Models

Existing public R&D datasets are not adequate for comprehensive testing:

- ▶ There are too few of them
- ▶ They are too small
- ▶ They are often incomplete
- ▶ They are too easy to solve
- ▶ They are not realistic





# GRID DATA

(Generating Realistic Information for the Development of Distribution And Transmission Algorithms)



## Goals

Development of large-scale, realistic, validated, and open-access electric power system network models with the detail required for successful development and testing of new power system optimization and control algorithms.

Kickoff Year	2016
Projects	7
Total Investment	\$11 Million

## Project Categories

- Transmission, distribution, and hybrid power system models & scenarios
  - Models derived from anonymized/obfuscated data provided by industry partners
  - Synthetic models (matching statistical characteristics of real world systems)
- Power system model repositories
  - Enabling the collaborative design, use, annotation, and archiving of R&D models

# Other energy-related algorithm competitions?

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- ▶ Transmission expansion methods
- ▶ Demand/renewable generation forecasting
- ▶ Load disaggregation algorithms
- ▶ Event identification and classification (using PMU data)
- ▶ Asset health monitoring/diagnostics (failure prediction)

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Program Director  
Advanced Research Projects Agency – Energy (ARPA-E)  
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timothy.heidel@hq.doe.gov



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