BACKGROUND PAPER ON DISTRIBUTED RENEWABLE ENERGY GENERATION AND INTEGRATION

PREPARED FOR

TECHNOLOGY EXECUTIVE COMMITTEE (TEC)
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BONN, GERMANY

PREPARED BY

PAUL KOMOR
TIMOTHY MOLNAR

UNIVERSITY OF COLORADO*
BOULDER, COLORADO, USA

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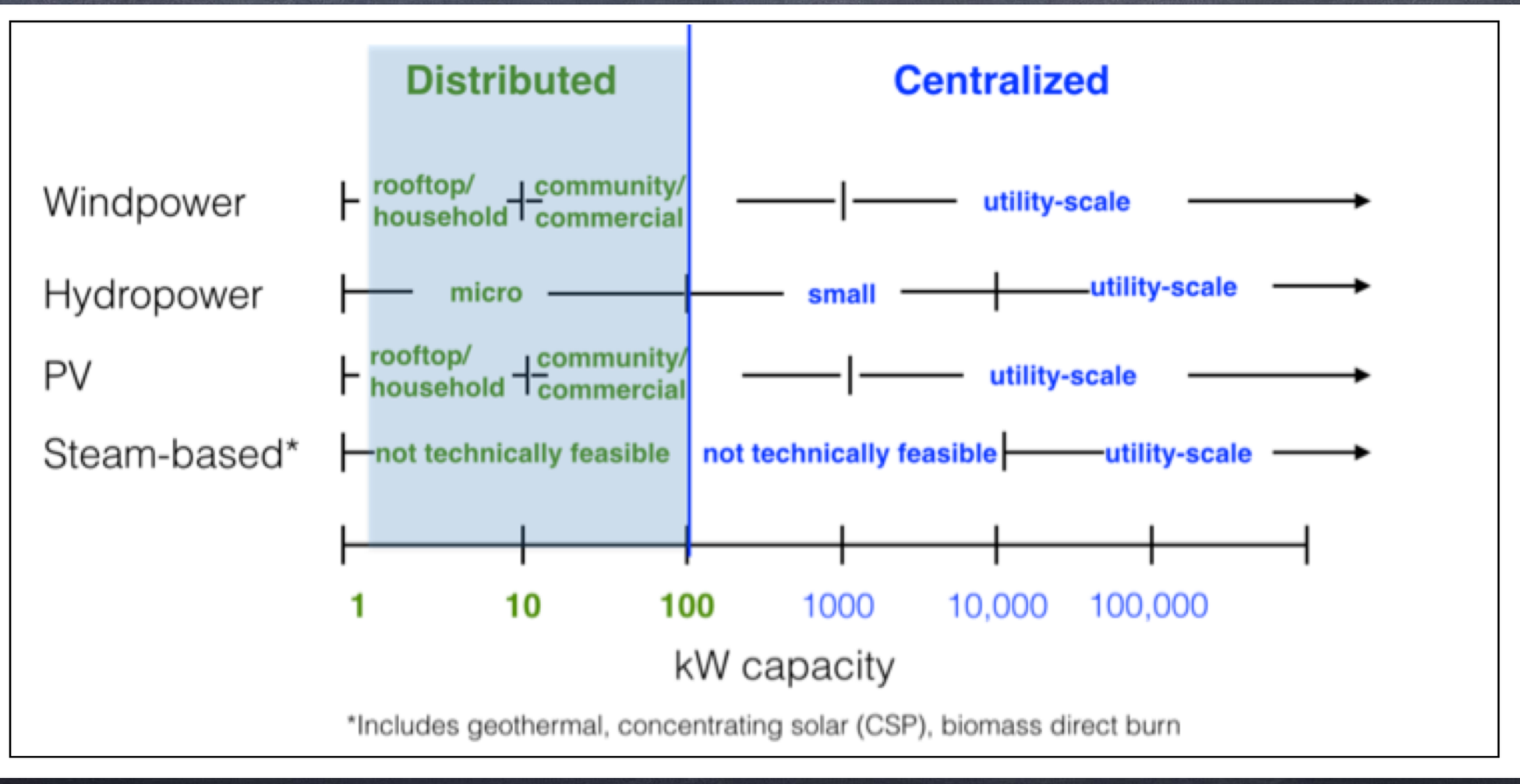
What does ‘distributed’ mean?

-Term used inconsistently in the literature
-Generally: Larger than off-grid, smaller than centralized
- Can be free-standing or tied to a centralized grid



Distributed and Centralized

-Determining optimal mix is a complex problem
-Costs reasonably well understood; social and environmental issues less so

	Advantages
Centralized	-Wide range of mature technologies -Lower per-kW costs -Higher load diversity->flatter demand profile -Well-developed industry
Distributed	-Appropriate for small/remote communities -Greater system resilience due to diversity of supply -Reduced transmission and distribution (T&D) losses -Allows for direct private investment in generation

What are the distributed technologies?

-Vary widely in market maturity, fuel needs, variability, and other variables

-PV: significant recent module price drops -> larger proportion of local content

Technology	Typical Cost (USD/kW)*	Resource or Fuel Needs	O&M Needs	Variability of Output – Diurnal**
Distributed PV system	2 to 5	Sunlight	Low	High
Methane digester	3 to 6	Dung	High	Low
Micro hydropower	3.4 to 10+	Consistent water flows	Medium	Low
Small wind turbine	7	Wind > 3 meters per second (m/s)	Medium	***

*For sources, see discussion in text. These costs do not include storage.
**Other time scales may be of interest as well, notably annual and 'climatic' (longer-term). For these time scales, variability may vary by location. For example, PV output will vary considerably over the course of a year for installations at greater latitudes, but much less so for installations near the Equator.
***Depends on specific location. Some regions show large day/night variability in the wind resource, others much less so.

Methodology for our report

-Literature review: recent (post-2010) evaluations of field experience with distributed renewables

-Emphasize developing country literature.

-Extract/summarize:

- Barriers
- Enabling Environments
- Policy Issues and Options

Perspectives/concerns vary by stakeholder

Perspective, Community, or Stakeholder	Concern or Issue
Technical and engineering	• Variability and grid integration • Technical reliability • Impacts on power quality
Financial and investment	• Policy uncertainty and political risk • Expected financial return • Default risk
Policy and regulatory	• Grid access rules • Equity and distributional impacts • How to allocate costs and benefits
Private sector	• Business risks (e.g., technical performance, regulatory change) • Expected return on investment • Consumer acceptance
Utility	• Grid operational impacts • Potential loss of revenue • Loss of control over generation assets

Enabling Environments

- Engage utilities as essential partners rather than opponents
- Leverage peer influences and personal networks within the community
- Standardize technologies and business practices
- Reduce perceived risk for investors and system owners
- Allow for innovative finance
- Offer sufficient financial incentives to attract private-sector investment
- Provide for system O&M

Policy issues and options

- Balance financial innovation and regulation
- Rethink public and private roles in electricity
- Reassess the utility role
- Rethink fossil fuel subsidies
- Derisk to attract private sector investment
- Limit policy uncertainty
- Build in-country capabilities

Earthrise, 1968