Are We Ready to Scale Residential Demand Response Globally?

Scaling Residential Demand Response with NLP and Data Analytics: A Framework for Policy Design

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1. The Challenge

Despite two decades of residential DR implementation, transferability to developing contexts remains uncertain due to interdependent barriers:

- **Technical gaps** — Infrastructure limitations in emerging markets
- **Regulatory immaturity** — Weak or non-existent DR frameworks
- **Consumer barriers** — Low trust, limited exposure
- **Evidence fragmentation** — Inconsistent lesson synthesis

A framework is needed to gauge feasibility and adapt DR to new contexts

2. The DRRF Framework

The **Demand Response Readiness Factor (DRRF)** systematically assesses DR implementation across diverse regional contexts through automation and evidence-based design

A Data Collection

Initial database search for literature with the DR Theoretical Framework + NLP integration to build comprehensive evidence base

- 5 DR Types
- 5 Dimensions
- 27 Criteria

Key stats on NLP integration

- **>71% match** — NLP accuracy vs expert assessment
- **30,000+** — Studies systematically analysed
- **200+** — Selected case studies across 16 countries
- **At least 10x** — Faster evidence synthesis

B Modelling

Data extraction of programme results and variables affecting DR; correlations analysis between outcomes & country/ programme characteristics

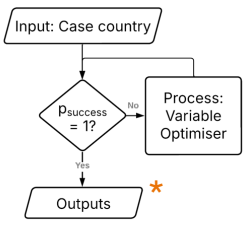
- **Variable Correlation Index (VCI)**
- **Country Similarity Index (CSI)**

VCI heatmap for relative importance of variables for DR programmes (excerpt)

	TOU	RTP	CPP	DLC
Smart meter availability	0.85	0.90	0.88	0.88
Dynamic pricing exists	0.82	0.88	0.85	-------
Electricity price for households	0.78	0.78	0.75	-------
Regulatory support for DR	0.75	0.72	0.80	0.82
Internet penetration rate	0.72	0.85	0.82	0.85
Smart home adoption	0.70	0.65	0.65	0.78
Energy literacy index	0.68	0.70	0.70	-------
Trust in utilities	0.65	0.60	0.78	0.80

C Case Run and Output

Run cases based on VCI & CSI iterative correlations to generate evidence-based policy recommendations



- **Output 1: Transferability** — *"Can we transfer from another country?"*
- **Output 2: Implementation Feasibility** — *"Can it work here?"*
- **Output 3: Adaptation Requirements** — *"What must change to make it viable?"*
- **Output 4: Outcome Forecasts** — *"What will we get if we do it?"*

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3. Transition Impact

Matches proven DR designs to local conditions and identifies the preconditions needed to make them viable

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Accelerating flexibility in developing power systems

Indonesia Case Study

Applied DRRF to Southeast Asia's largest economy, generating recommendations for DR deployment under 3 scenarios

1. **Current conditions** — Limited infrastructure, minimal regulatory framework
2. **Minimum viable conditions** — Essential DR requirements, acceptable risk levels
3. **Ideal conditions** — Advanced smart grid, comprehensive supporting DR regulations