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Ethics of algorithmic decision making on the smart grid

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What is the traditional grid?

- Large, centralised electricity generators
- Large, long distance transmission
- Sprawling, low voltage distribution
- Prioritisation around capacity and CAPEX
- Static management based on peak demand
- Syncronous generation and frequency inertia
- High penetrations of fossil fuel generation
- System blindness - set and forget assets
- designed for unidirectional flow

What is the smart grid? [1, 2, 3, 4, 5, 6, 7, 8]

- Combination of centralised and decentralised generation at varying scales
- Cyberphysical system: IoT integrated energy devices, artificial Intelligence, automatic and autonomous appliances
- Dynamic management: Real-time asset visibility, massive orchestration of DERs, dynamic pricing
- Optimisation, balanced load, generation and storage, lower prices
- High penetration of RE and storage
- "A seamless, cost-effective electricity system, from generation to end-use, capable of meeting all clean energy demands and capacity requirements" [US DoE]

How can we identify the ethical risks of the smart grid?

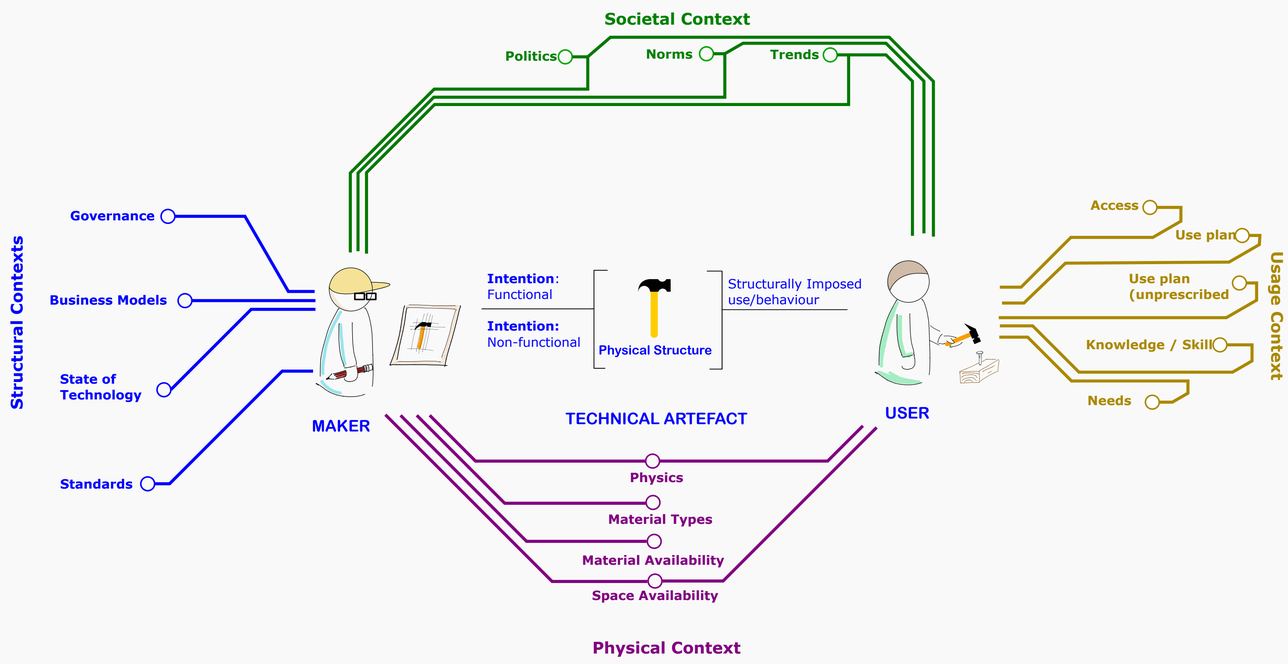
Applying the Structure-Intention Conception to the Traditional Grid

Functional:
- *Deliver electricity to homes*
- *Meet peak demand*
- *Minimise system costs*
- *Minimise energy prices*
- *Reliable/ secure energy source*
- *Manageable by humans*

Non-functional:
- *politically invisible (implicit)*

Existing structural realisation:
Internally Immutable Structures
- *Poles and wires*
- *Centralised energy resources*
- *Communications networks*

A Philosophy of Technical Artefacts:The Structure - Intention Conception [9, 18]



Applying the Structure-Intention Conception to the Smart Grid [1, 2, 3, 4, 5, 6, 7, 8]

Intention: Functional:
- *Deliver electricity to homes*
- *Accept and redistribute exported energy from homes, businesses*
- Manipulate demand and supply*
- Manageable by humans who defer responsibility automatic and autonomous system components*
- *Responsive to (near) real-time data*
- *Optimised costs for system*
- Optimised pricing for benefit of system and consumers*
- *Reliable/secure electricity supply*
- *Maximise sustainable energy sources*

Intention: Non-functional:
- Politically marketable (implicit)*
- Everyone benefits (explicit)*
- State-of-the-art technology*

Existing and expected structural realisation:
Internally immutable components
- *Poles and wires*
- *Centralised energy resources*

Somewhat internally mutable components
- IoT Communications, control*
- *Centralised energy resources*
- Distributed energy resources*
- *Communications networks*

Highly Mutable structures
- Virtual Power Plants*
- Algorithms*
- BigData models and supporting hardware*

*Causes of special issues on the smart grid

Special Ethical Issues of the Smart Grid

Changing status of users [11]

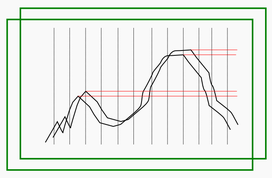
Research Question:
- How do we treat grid users and what is their status?

Citizen
Consumer
Asset manager
Asset Financier

Traditional Grid: the grid is for users, however under a
Smart grid: Those who don't participate in prosumerism may be excluded

Dynamic engagement with users [12]

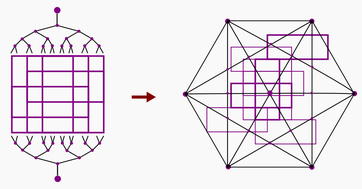
Research Question:
Who does dynamic pricing benefit and why?



Traditional Grid: Energy should be affordable for everyone
Smart Grid: Energy should be affordable when convenient and only for users who benefit the grid

Compounding Complexity

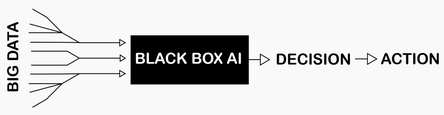
Research question:
- What are the risks of accepting extreme complexity?



Traditional grid: Centralised sociotectnical system - secondary effects likely and but predictable
Smart grid: Cyberphysical sociotechnical system - secondary effects inevitable, difficult or impossible to predict

Process and Accountablility

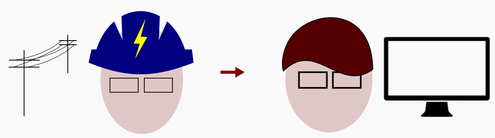
Research question: How can we guarantee due process and accountability if we cede responsibility to algorithms and AI? [13]



Traditional Grid: Human drive interpretable decision making and control of grid
Smart grid: Decisions made by black box algorithms and control enacted by autonomous and automatic systems

Shifting power among technical elites [14]

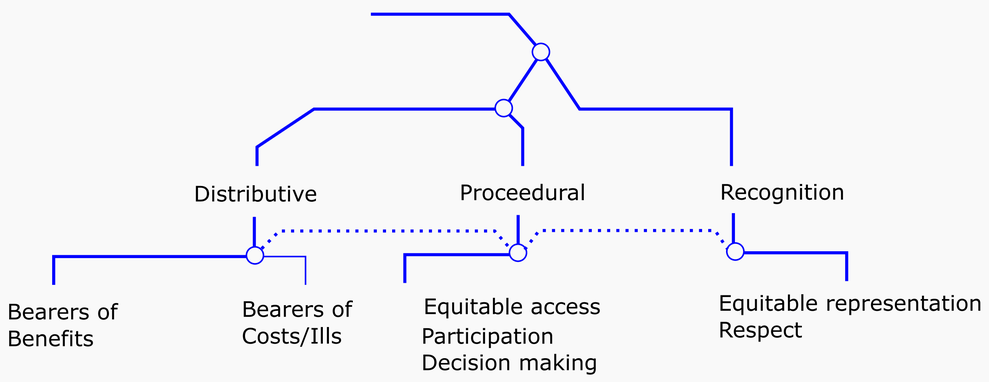
Research question: What compencies do we risk losing when system design and management shifts from power engineers to IoT and BigData professionals? And how does society oversee a technically elite domain?



Traditional grid: Power engineers oversee design of control systems
Smart grid: Data scientists, CS engineers, programmers oversee design of system

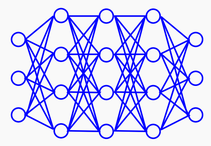
Conclusion: Methodologies to Wrangle Smart Grid Ethical Issues

Energy Justice Framework [17, 18]



Grid AI & Algorithm Oversight [15, 16]

Description of the grid as a complex technological artefact:
- Structure-intention conception
- Identify the makers, users and contexts
- Describe intention, structure and constraint
- Recognise structural power



Identify risks:
- embedded values and politics
- Black box algorithms
- Implicit goals
- Transmogrification
- embedded biases, data and algorithms
- Conflicting goals and values

Identify opportunities:
- Machine ethics advancements
- Supererogation
- Enhancement of human dignity and flourishing

AI and algorithmic ethical framework:
- Unification and extension of classical ethics
- Duty assignment, responsibility, and defined scopes of agency

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