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## **THE INDUSTRIAL ORGANIZATION OF ENERGY SYSTEMS: A TRANSACTIONAL APPROACH**

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### **Industrial organization**

In the modern view, the industrial organization of a system is determined by: basic economic elements — resources, technologies, and preferences; the institutions of political power, property and exchange; and emergent organizations that implement transactions — businesses that form, fund, and construct “assets” and operate internal transactions in primary factors and intermediate goods, and commercial structures mediate external transactions between them.<sup>1</sup>

Organizations of business and exchange are structured to minimize the total cost of production, which comprise “the total costs of transformation and transaction.”<sup>2</sup>

Organizations and individuals have influential stakes in both economic property and political institutions<sup>3</sup> Change in the basic elements and in the institutional and organizational structure co-evolve.

Transparent, accessible markets exploit returns to scale in the pre-commitment transactions costs of measurement, search, bargaining, and contracting. But regulated or contractual bilateral exchange mechanisms may limit post-commitment costs of monitoring, enforcement, and hedging flexibility. Such exchange structures provide market power as well. Thus there is a tension between the public efficiencies of unbundling and “competitization” of intermediate transactions, and the private gains of stakeholder with market power in less contestable exchange structures.

For systems that are facility-intensive, until institutions for business formation and operation are transparent and accessible, and external markets for funding, and for inputs and outputs are perfectly competitive, external transactions have a bilateral, strategic component that, with fixed facility investment, raises the potential for “post-commitment counterparty opportunism.”<sup>4</sup> In such an environment, the formation and funding of facility investment requires the formation of a post-commitment exchange environment that protects the appropriation of operating returns from counter-party opportunism. (This is called “project formation”, leading to financial close.) Ownership integration, partnering, contracting, and market regulation are structures and mechanisms for this purpose.

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<sup>1</sup> “Institutions, together with the standard constraints of economic theory, determine the opportunities in a society. Organizations are created to take advantage of those opportunities, and, as the organizations evolve, they alter the institutions.” Douglass North, 1990, 7.

<sup>2</sup> North, *op.cit.*, 28.

<sup>3</sup> “Organizations with sufficient bargaining strength will use the polity to achieve objectives when the payoff from maximizing in that direction exceed the payoff from investing within the existing constraints.” North, 1990, 79. “Institutions are not necessarily or even usually created to be socially efficient; rather they, or at least the formal rules, are created to serve the interests of those with the bargaining power to create new rules. In a world of zero transaction costs, bargaining strength does not affect the efficiency of outcomes; but in a world of positive transaction costs it does.” (North, 1993).

<sup>4</sup> North state, “institutions exist to reduce the uncertainty in human interaction.” (*op.cit.*, 25). In think this can be sharpened — in an economy with recurring transactions and capitalistic production modes, institutions exist to limit post-commitment strategic opportunism. Williamson says that incomplete contracting leads to “self-seeking with guile.” This is unnecessary. All that is needed is opportunism given opportunity. Clausewitz says to plan for opponents’ capabilities, not intentions.

## **Energy systems**

Energy systems have a specific set of technical and economic characteristics that together distinguish them from other capital and resource-intensive activities and dictate the structure and evolution of their industrial organization:

- Energy services (heat, motive power, appliance drive, feedstock) are necessary (no possible substitution away) to life at any level of real income. As a consequence, the security and equity of the supply of energy carriers is always a focus of societal and government concern.
- Through the chain of transformation and transportation from primary resource to end use service, the energy carrier (crude oil and products, natural gas, coal, electricity, hydrogen?) retains its “energy” identity embodying value-added through the chain.
- Energy carriers are “commoditizable”<sup>5</sup> Their value at intermediate delivery points in the chain is defined by end use market value and netbacks through the physically and commercially available transportation links. This broadens the competitive liquidity of markets for energy carriers if downstream markets and intermediate transportation grids are competitively accessible.
- Between any two transformation activities (e.g., production, refining, generation) the transportation/distribution grid defines the feasible counter-party transaction set, and is specific to an energy type. Further pipes and wires are fixed and committed to a specific bilateral supply-demand. Ships, trains, and trucks are specialized but deployable, but require specialized terminalling.
- The energy industry itself largely forms, funds, constructs, and operates its transportation/ distribution grids. In this it necessarily differs strongly in formation challenges and its transaction structure from manufacturing, which generally has competitive access to more generalized, independently funded, constructed, and operated air, rail, highway, and shipping grids.

## **Evolution and unbundling**

This set of economic and technical characteristics conditions the institutions and the business and commercial structures that constitute the industrial organization of energy systems. The overall principal is that the scale and scope of transportation grids connecting transformation facilities defines the feasible transaction structure. Since projects within it are formed by the industry are largely formed and funded and operated by industry itself, the commercial structures are formed to support investment. To limit post-commitment opportunism, this commercial structure often took the form of regulatory franchises, or contractual limitation on access and trading optionality.

In the early days, these took two forms, for distribution utilities such as electricity and manufactured citygas these were municipal and regional state-owned or investor-owned and regulated monopoly franchises. For geographically extended, international chains, these were vertically integrated (oil and oil products) or contractually integrated structures (natural gas pipelines and LNG).

As the scale and scope (the multi-connectedness) of transportation/distribution grids expands, the asset specificity of transformation facilities decreases, commercial or institutional limitation on access and trading become less needed for funding and more costly in terms of foregone optionality.

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<sup>5</sup> In the sense that they can be sufficiently well-defined to be traded anonymously. The comparison is to the canonical Fisher Body-GM case (Coase, 2000), where the car bodies are buyer-seller specific. Unleaded mogas traded on the NYMEX spec is not.

Induced change in the industrial organization is driven by the balance of increased transactional and trading efficiency, offset by the vested interests of stakeholders in the existing restrictive structures.

Change in industrial organization takes the form of unbundling across four dimensions: vertical, lateral, functional and financial. Examples, to be more fully analyzed, follow.

*Vertical unbundling:* the introduction of explicit markets for the energy good, generally at the transition points between transportation output to conversion input of conversion output to transportation input. Examples:

- Prior to the 1960s, oil companies in international trade<sup>6</sup> produced from concessions, moved crude oil in their own ships, through their own refineries, often through their own distribution facilities with the first sale at the refinery rack refinery rack or the pump. When the 1956 closure of the Suez Canal required much more long-haul shipping, the entry of the Greek shipowners opened up both an FOB Persian Gulf market for crude oil and a market for crude oil shipping services. Nevertheless, the international crude oil market remain largely the domain of integrated players until Saudi Arabia's 1985 introduction of product market-based netback sales (in place of Government Selling Prices), eroded the bilateral relationships between companies and countries. This is an example of the vertical unbundling of the energy good chain, and the lateral and functional unbundling of shipping. It illustrates the principle that a competitive market in the energy good requires a competitive market in the transportation service.
- Following forced sales of industrial power "over the fence" by PURPA in 1978, we discovered that with appropriate access to transmission, a competitive wholesale market for generation was feasible.<sup>7</sup> With the creation of power pools in the USA, transmission owners gave up merchant activities and sold transmission services to the ISO, who charged electric energy sellers and buyers for use in a variety of ways, the most efficient being on the basis of LMP differentials.
- In the UK's unbundling of the England-Wales electricity system, two private and one (nuclear) public generators were created, the transmission grid was separated, and the 12 regional distribution/retail companies were privatized. The resulting generation market was found not to be competitive, and significant capacity was transferred from the two dominant firms to independent companies. On the other hand, the generators have significantly reintegrated downstream around the transmission segment, and now collectively own essentially all of the regional distribution companies.

*Lateral unbundling:* the disaggregation of ownership of a collection of assets serving a common market. The unbundling of transactions through an energy chain is often part of larger restructuring that may entail privatization of state-owned assets, and deregulation and competitization of markets for energy goods and energy facility services. Examples:

- When integrated oil companies merge, regulatory authorities force divestiture of refining and marketing assets sufficient to achieve a competitively acceptable market share structure.
- In 1935 in the USA, the Public Utilities Holding Company Act (PUHCA) broke up the trusts that controlled electric and citygas utilities and vitiated local regulation. (Three holding companies controlled about 50% of US electricity sales).
- In the USA, the formation of power pools is often accompanied by lateral unbundling of generation to achieve a competitive market structure. In California, famously, the retail utilities were forced to divest their generating assets while being denied any access to a forward market. This, together with retail price caps, denied them any hedge of their

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<sup>6</sup> In 1960, Exxon reintegrated upstream in the USA by buying Humble Oil for its producing assets.

<sup>7</sup> The pathbreaking study was Joskow and Schmalensee (1983).

service obligations, and when the capacity crunch hit, the resulting credit squeeze amplified the financial collapse.

*Functional unbundling:* the disaggregation of ownership and production of facility services from merchant activities in the energy good, by the introduction of an explicit transaction in asset services. Examples:

- Transportation facilities that are mobile, ships, trains, and trucks, often originate or are unbundled to sell services. Note that these require locational fixed infrastructure. Ports for ships are typically associated with energy sellers or buyers. Grids of tracks and highways are locationally fixed and may begin as bilateral connections, but evolve into multiply-connected networks providing multiple party access to (for) each buyer or seller or both.<sup>8</sup>
- Transportation facilities that are locationally fixed, pipes and wires, may be established as (often regulated) service providers. In 1993 in the USA, following the deregulation of natural gas wellhead pricing and the attempted imposition of open access (Order 436, 500) for interstate pipelines, FERC Order 636 (and 636A) unbundled the merchant operation of the pipelines, requiring them to allocate their purchase contracts to their LDC customers along with rights to transmission capacity, which could be “released” into a competitive market for transportation services. This made the pipelines regulated transportation service providers, created a competitive secondary market for transportations services, and enabled a competitive market for natural gas from wellhead to citygate.
- Unbundling of transmission systems for natural gas and electricity is being much more stoutly resisted by the much stronger regional and national integrated electricity and gas transmission utilities. The EU Commission Report on the Functioning of the Internal Market in Electricity and Gas: “Wholesale markets still a very high level of concentration, creating scope for incumbents to raise prices. Consumers are denied choice due to the difficulties faced by new suppliers trying to enter the markets. Insufficient separation of infrastructure and supply functions prevents new entrants from reaching the final consumer. There is no significant cross-border competition – for gas, it is difficult to secure transit capacity on key routes and for electricity there are long-term capacity reservations and not enough inter-connector capacity. A severe lack of transparency prevents new entrants from competing effectively. Finally, prices often are not determined on the basis of effective competition.”<sup>9</sup>
- In the commercialization of LNG trading, the liquefaction project is now often relegated to the role of tolling service provider freeing IOCs to retain title through the trading chain, and exploit the destination arbitrage opportunities.<sup>10</sup>

*Financial unbundling:* the disaggregation of price risk from physical ownership and acquisition or delivery. Examples:

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<sup>8</sup> The provision of assets services can have its own staged chain that can be unbundled in alternative ways. Shipping provides examples. Ships can be owned and used by an integrated energy merchant. A ship can be offered by the owner under a *bare-boat charter*, under which the charterer equips, crews, and operates the ship. A ship can be offered under a *time-charter*, under which an equipped, and crewed ship is operated by a separate enterprise, but scheduled over an extended period of time by the charterer. Under a *transportation agreement*, the transportation of goods may be provided. Within these arrangements, the ship owner, ship operator, and use of the transportation services may be distinct enterprises bearing different aspects of control, costs, and liability.

<sup>9</sup> <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/05/1421&format=HTML&aged=0&language=EN&guiLanguage=en>

<sup>10</sup> Nissen (2006).

- Futures exchange and over-the-counter financial forward markets for futures and options implement price risk management.
- In electricity markets, a contract-for differences and financial transmission rights effectively implement fixed-for-variable price swaps and support the separation of the physical dispatch, while hedging revenue risk for committed capacity for generators and service obligations for load serving entities.

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