# Combining Actor Network Theory and the Multi-Level-Perspective of Transitions Management. Can we better explain agency of actors or processes that advance niche innovations?

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## Abstract

Transitioning to renewable and clean energy technology is becoming increasingly important. However, many questions arise on how to break from the current socio-technical regime to achieve Paris commitments. This article combines the multi-level perspective of transitions management ("MLP") together with actor network theory (ANT) to determine if the combination (1) results in a coherent explanation of change; (2) adds value in explaining change and thereby developing strategies of change.

This paper supplements MLP with ANT to address two identified gaps in the MLP literature:

1. Understanding the agency of actors and groups and the interplay of different types of actors in transitions; and
2. Identifying the processes and mechanisms that advance niche innovations creating path-breaking innovation.

ANT extends the participants of actors in the social (beyond the traditional focus of individual personal agency and humans (individually or collectively) affecting social processes) to include objects, such that the human and non-human actor participants act as a durable whole. ANT also focuses on the creation of network assemblage (arguably equivalent to STRs). This article argues the ANT process of translation can enrich STR and niche developments. Combining the multi-level perspective and actor network theory can explain switch points and transitions through relations of actors and actants; (2) The creation of an effective network assemblage sets the stage for a switch point and transition; (3) Missing elements of an effective network assemblage highlight impediments to transition to renewable energy and clean energy technology.

## Introduction

Given gaps between Nationally Determined Contributions and mitigation commitments required to achieve Paris goals of limiting global warming, transitioning to renewable and clean energy technology is increasingly important. Our current carbon dependent world often lacks the imagination to envision a carbon neutral world, much less build a pathway to achieve it by mid century. Significant change is becoming increasingly urgent, but how can path dependent socio-technical regimes (STR) undergo the change that is required? Can we learn more about change, and how change might occur, by combining models of change?

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This paper combines the multi-level perspective of transitions management ("MLP") together with actor network theory (ANT) to determine if the combination (1) results in a coherent explanation of change; (2) adds value in explaining change and thereby developing strategies of change. By addressing perceived gaps in the MLP literature relating to agency of actors and groups and identifying the processes and mechanisms that advance niche innovations ANT offers a potential supplement to MLP.

## Socio-Technical Regime (STR) and the Multi-level Perspective (MLP)

Scholars of science, engineering, and technology have studied the stabilization of technological development through the interaction of scientists, policymakers, end-users and activists. From this transitions management emerged (Geels and Schott 2007) in the late 1990s as a significant body of literature exploring changes in sociotechnical regimes (STRs) (Falcone 2014). The STR is a relatively stable configuration of artifacts, techniques, institutions (rules, practices), and networks that together determine the development of a technology and surrounding innovation (Rip and Kemp 1998). The multi-level perspective incorporates a complex structural model to explain transitions and change allowing analysts to describe both systemic and radical innovation as the outcome of the multi-actor, multi-level process. Directed change occurs through the interaction between macro-level social and political developments that are external to the STR called 'landscape' level changes and innovations within and around the STR taking place in protected technological 'niches'. These niches face technological adoption hurdles in the form of professional skepticism and economic challenges.

The multi-level perspective allows for STRs and transition pathways to be identified and traced historically using the metaphors of STRs - landscape, and niche innovation. Developments occur within each level at different speeds, scales, and logics, which may cause contradictions, tensions and disruptions that stretch linkages, or build pressure for change (Geels 2010). Landscapes provide the exogenous policy context for macro level change. This change is generally slow and incremental placing often downward pressure on the STR. The regime, characterized by established communities of scientists and engineers along with policy makers and interest groups, exists as a network of actors who advance specific goals that may advance or temper technological development patterns. The STR and landscape interact with niche innovations to determine whether the sociotechnical regime will change through learning or performance improvement. The STR perspective can be used to assess historical transitions in STRs and project future oriented scenarios allowing the active management of transitions that encourages reflexivity about transitions (Hoffman and Elzen 2010). Transitions management focuses on why STRs change.

## Actor Network Theory and Reassembling the Social

The energy system is characterized by social and technical systems that intertwine. These intertwined systems could be investigated by examining the network of pertinent actors and their activities in relation to the large socio-technical artifact of the energy system operating at different levels of scale (van der Shoor et al. 2016). However, ANT introduces different conceptions that may be challenging to the extant STR and MLP.

There are several disparate conceptions in reassembling the social that conflict with the MLP:

First, the social is perceived as flat, or without levels of scale. ANT does not migrate between the local interaction and the global context but instead relocates the global in order to break down the automatism that leads from interaction to context. Instead a 'Big Picture" or panorama is created that illustrates the connectedness of everything (Latour 2005: 187). As a result scale is not something set up by the social scientist before doing a study. Is it possible to incorporate ANT when it rejects scale and levels into the MLP? Epistemologically the two approaches to society appear diametrically opposed, and thus the methodology of the MLP and ANT would appear to be irreconcilable.

Second "no place dominates enough to be global and no place is self-contained enough to be local" (Latour 2005: 204). What actors do in the study of ANT is redistributed and re-dispatched. The interactions of actors is not geographically confined and is conceived in a multi dimensional manner. There are several conceptions of interactions. First, interaction might be isotopic (what is occurring at the same moment in any place is coming from many other places, distant materials and faraway actors); interaction is synchronic such that its significance in time is always folded, reoccurring but never the same in characteristics such as quality or duration; interactions are not synoptic such that the participants are simultaneously visible at any given point; interactions are not homogeneous or having the same material quality as interactions occur at differing times; interactions are not isobaric as some actor's and interactions are stronger, and some are weaker (Laour, 2005). Because of the complexity of these interactions, to obtain 'complete' human actors, human actors must be composed out of many successive layers in order to delineate individuality, subjectivity, personhood, and interiority because these circulate. Because of the ubequetous nature of human actors and their interactions, an inherent conflict with the components of the MLP occurs.

Thirdly, by localizing the global and distributing the local (combining the first and second points above), both at the same time, what emerges is the need to establish a conduit every time there is an action to be analyzed. Every action maintains a more or less durable connection. These durable interactions create sites of connections and attachments. The study of these connections engenders: (1) the identification of the type of connectors that make the transportation of agencies over great distances and the characteristics that make these connectors efficient; (2) the determination of the mediators that "transform, translate, distort and modify the meaning or the elements they are supposed to carry" (Latour, 2005: 39). These mediators are contrasted with intermediaries that simply transport meaning or force without transportation; here the identification of mediators is much more arduous and the act of transforming mediators to faithful intermediaries (or black boxes) is the rare exception worthy of study and documentation; (3) the determination of what lies between the connectors. This inquiry focuses on the extent of our ignorance in relation to what lies between the social connections.

This third characteristic of reassembling the social and the three lines of inquiry it engenders possibly entails a form of grounded theory making. Interactions are studied in and of themselves in an inductive manner to determine which are of more or less durable connection and from these which create sites of connection and attachment. From this the connectors that can bridge

distances and make connectors efficient, the determination of what interactions are transformative, meaning changing mediators, and then the interactions that lie between the connectors all form the basis of inductive research activity with very little semblance of a pre determined enduring STR and a MLP.

In ANT "neither society nor the social exists in the first place" (Latour 2005: 36). Social links have to be traced by their circulation with different vehicles and social links can't be substituted by one or another. There is no master vocabulary of social and society with which to draw. The adjective social designates two phenomena; the substance and also a movement between non-social elements and when taken in a solid form it loses its ability to associate. "When it's taken as a fluid, the social again disappears because it flashes only briefly, just at the fleeting moments when new associations are sticking the collective together" (Latour 2005: 159). Latour (2005) distinguishes ANT from the sociology of the social, which tries to keep social connections together as firmly as possible. This inductive reassembling of the social that arguably rejects traditional sociological concepts of actor and agency initially appears quite contradictory and irreconcilable with TM and MLP. However there are some concepts that have particular appeal.

Agency of Actors (and Actants)

ANT extends the participants of actors in the social (beyond the traditional focus of individual personal agency and humans (individually or collectively) affecting social processes) to include objects, such that the human and non-human actor participants act as a durable whole (Latour, 2005; Ross and Berkes, 2013)). The interactional effects and relations of humans and objects are explored, acknowledging that both humans and objects have no inherent qualities, attributes or agency on their own, but act in connection to one another. Objects that exert influence or agency and are meaningful within the social system in the network or amongst relationships are termed 'actants' and may be biological or technical. In the context of this paper, actants include coal power generation, renewable such as wind and solar, and the electric power grid.

ANT focuses on the creation of network assemblage, or durable networks (which are arguable equivalent to STRs). The durable whole (human and non human actants) is referred to as the 'network assemblage' that are ordered relationally, as human and technical components form a unified whole through complex, dynamic, constant coupling, and continuous flows of otherwise fragmentary objects (Muller, 2015). Social order is created through the relationships formed in networks of people and objects and is 'black-boxed' when humans and objects struggle (perhaps not intentionally) and the network comes to look like a single point actor – an actor-network or configuration.

ANT Processes Advancing Niche Technologies

Both ANT and niche development in MLP explore how social phenomena and technological innovation come into being (Nyborg and Ropke, 2015; Smith and Raven, 2010). Because of this, ANT can supplement the concept of niche development in MLP. In MLP, niche development is the processes and mechanisms that advance changes in mainstream selection environments favouring path-breaking technological innovation (Smith and Raven 2010). This process of ordering or creating a network assemblage in ANT is also called a process of translation whereby

the network assemblage gains credibility or solidifies. A translation begins with problematization, or the framing of an assemblage as vital to addressing a pressing problem (Latour, 2005). (1) Utilizing the STR of coal production in Saskatchewan illustrates that: Combining the multi-level perspective and actor network theory can explain switch points and transitions through relations of actors and actants; (2) The creation of an effective network assemblage sets the stage for a switch point and transition; (3) Missing elements of an effective network assemblage highlight impediments to transition to renewable energy and clean energy technology.

This paper focuses on two areas identified in transitions management requiring more work:

1. A better understanding is required of the agency of actors and groups in transitions (Markard et al. 2012) and the interplay of different types of actors (Musiolik and Markard 2011). Actor conflicts and framings are important in transitions and their decisions impact all levels, erogenous factors and processes of the STR (Jorgenson 2012). Niche solutions require advocates within different institutional positions to present them as a realistic resolution to instabilities such that they are optimized over the routines in the wider socio-technical regime. Because this process involves power and antagonisms, it is inherently political (Mouffe 1996).

The study of actors will be enhanced utilizing actor network theory (ANT), which postulates that artifacts are not things in the usual sense but nodes in a network containing devices and people in interlocking roles (Feenberg 1999). "The dualism between humans and objects is transgressed: everything – people, machines, ideas, etc. – is treated symmetrically and explored as interactional effects" (Nyborg and Ropke 2015: 167). Interactional, or network effects refers to the relations of entities with other entities; entities have no inherent qualities, attributes or agency on their own (Wong 2016). The concept of agency is also expanded from the traditional focus of individual personal agency, or the ability of humans (individuals or collectives) to affect social processes through social networks (Ross and Berkes 2013) to include more than just human actors, but also non-human actors (Latour and Johnson 1988).

ANT examines society as consisting not only of people but the relations between people and the material objects surrounding them (Latour 2005). ANT explores how social phenomena come into being (Nyborg and Ropke 2015). Human and nonhuman actants develop social ordering or structure, and the rigidity or fluidity of the structure of these networks depends on the way the actants continuously form networks among each other (Murdoch 1998). The term actant accounts for the following attribution of meaning: any entity within the social system is meaningful because of the network of relationships it shapes with others and not the existence of the entity per se (Dwiartama and Rosin (2014). An actant is any non-human component (biological, technical or otherwise) exerting influence or agency over the network (Risan 1997).

By way of example, Portugal's naval power for 150 years is due to the agency of actants: ships, and spices (Law 1986). A Human food consumer is formed by the relationship with farmers, the foods eaten, retailers. Without these actants the meaning of the human as food consumer perishes (ibid.) and this is true of non human actants as well including technology, ideas, commodities etc. ANT extends the participants of actors in the social to include objects such that the human and non-human actor participants act as a durable whole (Latour 2005).

2. The second area of focus is niche development and the processes and mechanisms that advance changes in mainstream selection environments favouring path-breaking innovation (Smith and Raven 2010). Niche development is informed by diverse political narratives that occur across time and space, and engage in processes of shielding, nurturing and empowering of new technology. More reflection on what niche development and protection is, where it comes from, who is involved in shaping it and how it is transformed and declines as transitions come about is required. Not all proponents of niches enter into advocating for their technology on equal basis; the role of political narratives and institutional change is important (Hardy and Maguire 2010).

Niche development will be considered in relation to ANT and the creation of the network assemblage, or durable networks. The durable whole (human and non human actants) is referred to as the 'network assemblage' that are ordered relationally, as human and technical components forming a unified whole through complex, dynamic, constant coupling, continuous flows of otherwise fragmentary objects (Muller 2015). Social order is created through the relationships formed in networks of people and objects and is 'black-boxed' when humans and objects struggle (perhaps not intentionally) and the network comes to look like a single point actor – an actor-network or configuration. This process of ordering is also called a process of translation.

A network assemblage gains credibility or solidifies by moving through a process of translation. Translations begins with problematization or the framing of an assemblage as vital to addressing a pressing problem (Latour 2005). Actors must regard a technology as necessary for their interests and a particular storyline and scenario evolves (Callon 1986). This problematization creates roles and identities for each actor in the network, thus humanizing the technology with a degree of stability and relevance (Mahring et al. 2004). It is then through a process of interesessment that actors and their support structures enroll others thereby expanding and strengthening their networks through a subtle practice of indoctrination and enlistment (Latour 1987).

ANT involves five steps that are the pre-requisites to an effective actor network:

> 1. Organization of the world: the formation of arguments to support the overall objective, using various instruments to build a credible supporting evidence base. Including provision of reliable information and technical calculations.
> 2. Autonomisation: the position reached when actors have assembled sufficient evidence to support their views and are credible enough to be considered an 'authority' on a particular matter. Once achieved, actors are in a position to convince others of their arguments and form 'alliances'
> 3. Alliances: Actors cultivate interest amongst powerful groups and institutions and enroll them into a network.
> 4. Public representation: Promoting public acceptance of the idea by aligning it to everyday practice.
> 5. Links and knots: achieving all of the above activities simultaneously and in a joined up fashion.
> (Ambrose et al., 2016)

Problematization occurs within the organization of the world in interessment and enrolment occurs between the stages of organization and autonomisation (Boelens 2010). Actor-networks rarely operate in isolation but interact and draw support from other networks such as finance or technical matters (Rydin 2007).

## Integrating STRs, MLP and ANT Methodologically

The integration of MLP and STRs methodologically appears challenging. Latour (2005) starts from a point of induction. The identification of actors and actants and their interactions in a manner that eventually identifies connections and mediators. By casting off "agency, structure, psyche, time, and space along with every other philosophical and anthropological category" (Latour 2005: 24) it is difficult to envision how very well defined STRs, MLP, niche technologies can integrate with ANT.

However, use of inductive methods such as grounded theory, do apply loose forms of categories (Strauss et al. 1994) that would allow for an analysis of data in a manner that can categorize ANT interactions and connections in relation to the categories and concepts emerging from TM and MLP. What is more, theoretical thematic analysis pays attention to pre-existing themes that exist in the literature and latent thematic analysis also considers not just one dimension of the data but searches for deeper meaning (Braun and Clark 2006). It is the authors submission that it is possible to interpret data initially with a theoretical framework and leave room for the possibility of the data to contribute to the reformulation of some aspects of the theoretical framework (Fereday and Muir-Cochrane 2006). This methodology allows for both a deductive and an inductive process.

## Analyzing the switch point of Saskatchewan's STR

Saskatchewan's current portfolio of electricity production is based on coal, but it is in the process of transitioning to a new socio-technical regime. Climate change is clearly problematized with 68% of residents concerned about it and wanting an effective solution (Nelson 2012). At the national level a carbon price was announced starting with $10in 2018 and rising to $50in 2022 (Harris 2016). However the Saskatchewan government intends to address climate change through adaptation and innovation including new technologies such as Carbon capture and storage (GS2017). Two historical epochs are identified in Saskatchewan: The first epoch is from 1890 to 1949 and is characterized by the appearance of electricity and its development of usage. Here the STR of the provincial electrical transmission grid is created. The second epoch is from 1950to 1993 when coal becomes 'king' and the dominant power source. These switch points were identified in Hurlbert et al. (2010; 2011).

This paper analyzes these switch points of the past. In the analysis of historical switch point that created the coal and carbon dependent STR of power production we seek to know if the combination of MLP and ANT (1) results in a coherent explanation of change; (2) adds value in explaining change and thereby developing strategies of change.

The Rise of the Provincial Electric Grid

At the beginning of the 20th Century Saskatchewan's electricity supply was based almost exclusively in urban centers where kerosene and coal oil generators created electricity and distributed it in small local municipal systems mostly for domestic lighting markets. The first power production plants were located in Regina, Moose Jaw, and Prince Albert, but many communities followed suite early in the 20th Century either building their own municipal plants or allowing corporations to provide electricity generation and service. In this time frame electricity drove fans and machinery in factories, but the widely dispersed rural agricultural population had little industry. In Saskatchewan electricity generation replaced the use of blocks of ice for refrigeration with electrical refrigeration, coal or wood stoves with electric cooking ranges, and coal-oil and kerosene lamps with electrical lighting. Approximately 119 generating stations with different technological systems (steam, kerosene, diesel generation) provided often-unreliable service (having only one generator and a small system) with many cost challenges (Government of Saskatchewan 1997). The prairie landscape was dotted with municipal and private plants.

The major actors and actants at this time appear on Table 1. Electrification was slow in the rural areas and technological innovation stymied because of the reliance of municipalities on electricity generation as a source of revenue and the inability of municipalities to attain necessary funds for electricity infrastructure improvement. These issues resulted in regime actors losing faith in the existing regime and inequities across the province especially in relation to high rates and limited service (White 1976). Transitioning to a new STR was not an easy task. The position of the Government was unclear. It was described as, " it cannot be said that Saskatchewan has a power policy…It cannot be said that an effective bar against the wholesale acquisition of municipal plants exists….. that the power resources of the province are safe-guarded firmly for the people" (The Western Producer 1928).

The Saskatchewan government was instrumental in amalgamating small disaggregated coal oil and kerosene systems into one large provincial interconnected utility through a process of de-alignment and realignment starting with the 1927 creation of the Saskatchewan Power Resource Commission (SPRC) headed by Louis Thornton that was mandated to investigate the state of electricity service in the province (White 1976).

Table 1 Actor Transitions 1930-

| 1928 Major Actors | Replacement |
|---|---|
| Private companies | |
| Eastern Canadian Financial houses (stocks and bonds in lucrative utilities) | Saskatchewan government (1950-1980s) |
| Northern Light and Power Company<br>Senator Walter H. Schlosser of North Dakota (purchased Indian Head Wolseley Moosomin Balcarres – 185 miles of line)<br>Planned to exploit the southern coal fields of | Needed agreements with Estevan Melville and Yorkton so sold to Mid-West Utilities early 1928 |

| | |
|---|---|
| Saskatchewan | |
| Dominion Electric Power with assistance from Albert Emanuel Company New York; largest private system with Gravelbourg, Herbert Shaunavon Estevan Assiniboia Melville and Davidson | Taken over by SPRC by 1949 (Rediger 2004) |
| Montreal Engineering Company working for Royal Securities of Montreal and Calgary Power Company – 50 communities Regina, Moose Jaw, Weyburn and Estevan 500 miles transmission Calgary Power was owned by W. Max Aitken (later Lord Beavei-brook) of Calgary Power Company which was later TransAlta Utilities | Planned to construct a coal plant near Estevan and the coal fields and run lines to Regina, Moose Jaw and Saskatoon via Outlook and eventually interconnect with Calgary power lines. Only company that didn't build small plants, but closed down 25<br>Business model similar to eventual SaskPower (109) |
| Mid West Utilities Limited (later Canadian Utilities Limited) of Calgary subsidiary of American Intl Utilities Corporation of New Jersey – larger towns and Yorkton, Watrous-Nokomis area | Taken over by SPRC by 1949 (Rediger 2004: 28) |
| Actants: kerosene, diesel, coal oil, city lighting systems | |

Listening to extensive oral testimony, and inquiring in respect of the economics, supply options, scale, scope and capacity of existing plants, rural electrification, future transmission and transition pathways, the SPRC made two principle recommendations. First, it rejected hydroelectric power generation and second, it proposed the purchase of municipal power stations with transmission lines built to link the urban centers (White 1976). Specifically rejected were proposals that an inter-city pool of electricity be, created or a private company operate the provincial power production industry. At this time the proposal that a central plant of lignite coal generate the power for the province was rejected (even though recommended to the SPRC) (and part of the strategy of the Montreal Engineering Company and the Northern Light and Power Company listed on Table 1). The most significant act of the government on the recommendation of this report was the creation of the Department of Railways, Labour and Industries that was authorized to operate electric utilities. The Public Utilities Act was amended so that building any transmission line had to be approved by the Minister of Railways, Labour, and Industries. This hearing set the stage for the organization of the world into a provincial utility.

Four major power companies existed in 1929 vying for Saskatchewan's electricity business as described on Table 1. A private company, Northern Light and Power, had acquired the power plants at Indian Head, Wolseley and Moosomin; Montreal Engineering acquired Regina to QuAppelle plus many other centers; Dominion Electric acquired Biggar, Gravelbourg, and Gull Lake and others. The private company acquisitions were described as not altogether "philanthropic" (The Morning Leader 1928) Companies were also trying to sell electricity to cities. For instance the Dominion Electric and Calgary Power company approached Saskatoon to sell power in bulk at wholesale prices (Saskatoon Council Minutes 1928). The cry of public

ownership was being heard all over the province and the official Opposition was making the situation a political issue with the provincial government and cities (White 1976). This political situation was supplemented by financial interconnections.

Because the consent of SPRC was needed in 1929 to build transmission lines, private companies entered a period of uncertainty and stagnation. The government policy regarding transmission lines retarded private company expansion and they claimed they couldn't earn a satisfactory return on their investments. Significant development stalled in the 1930s during the Great Depression

Initially city systems were a means of delivering low cost power; over the years the plants became instruments of taxation for the city (as was the case in Saskatoon, Regina, Swift Current, Weyburn and North Battleford). However, when Moose Jaw, Prince Alberta, and Yorkton sold to private operators this benefit disappeared. The City of Saskatoon was one of the first major cities to accept power service from the SPRC. Saskatoon required more power to power its city and very early in the creation of SPRC accepted the Government proposal to have public ownership of power and supply. This alleviated the City of Saskatoon having to borrow funds for a new plant (White 1976). The City of Moose Jaw debated the fate of its electrical generating plant, but ultimately decided to sell it to a private company instead of the SPRC in 1930. In 1929, Moose Jaw called for tenders for the sale of its power plant. Two proposals were received, one from the SPRC ($1 million) and the other from Iowa Southern Utilities Company of Delaware ($2.9 million). The latter was accepted. The Iowa Southern Utilities Company of Delaware purchased its plant. Regina was opposed to the government plan to supply power. The Regina plant was the most financially stable with the lowest debt. It retained its plant until 1965 (White 1976). Financial and political interconnections lead to alliances of actors and public representation establishing the dominance of a provincial power entity.

In the early 1940s the provincial government called on Dominion-provincial cooperation to extend rural electrification, amended the Power Commission Act to outline expropriating property procedures and appointed the Saskatchewan Reconstruction Council to formulate a post-war Reconstruction and Rehabilitation program. The report of the program recommended the development of power sites from water and lignite coal (the previous vision of Northern Light and Power and Montreal Engineering). The Cooperative Commonwealth Federation, elected in 1944, chose to take over the holdings of remaining private companies and establish a province wide publicly owned monopoly.

Although stalled because of the financial and agricultural depression of the 1930s, and then World War II, by 1948 SPRC had 35 generating plants were spread though out the province with 8800 miles of transmission lines (SaskPower 2010). Power cooperatives that had some success in the States were not successful in Saskatchewan. It was believed that they would duplicate distribution infrastructure, create insurmountable metering problems, and costs power would be sold to the cooperative a concern(White 1976). These sentiments lead to the government provision of service to farms. The 1949 Rural Electrification Act commenced, testing the supply of power to 1,500 farms (mostly in the eastern half of the province concentrated in mixed farming areas). This Act ensured the integrated provincial grid was achieved and in 1958 the northern and southern grids were finally interconnected. Success was marked by the creation of

a new crown corporation renamed the Saskatchewan Power Corporation (eventually SaskPower) (The Power Corporation Act, R.S.S. 1978, C. P-15).

In 1949 the SPRC became a Crown Corporation. The system was almost fully integrated by 1965 forming a continuous network of 72,000, 138,000 and 230,000 volt transmission lines interconnecting generating stations and passing through load centers and linked with Manitoba.

Centralization of Electrical Generation and the Ascent of Coal

The 1950s was a period of building and consolidation for the SaskPower Crown. The three major power plants were Boundary Dam at Estevan, Queen Elizabeth Power Station in Saskatoon, and the Squaw Rapids hydroelectric power station north east of Nipawin. Six smaller plants supplemented these. Three were natural gas (Swift Current, Kindersly, and Regina). In the 1950s, along with rural electrification, the SaskPower's strategy was to develop a higher voltage transmission system to transmit power from large efficient plants into the distribution system. This eliminated former low efficiency diesel-generating plants. This organization of the world coinsided with the autonomisation of the mining economy and the alliances it created.

The 1950s began an era of mining and industry in Saskatchewan, which increased power generation requirements. In 1953 SaskPower started supplying power to oilfields in various parts of the province. One was near Swift Current to serve the Cantuar and Fosterton fields. To make efficient use of coal reserves in Estevan in the 1940s, the corporation began an expansion program in that area of the province with Estevan power providing the base load for southern Saskatchewan. In 1949 the first gas plant was commissioned at Unity (Rediger 2004). At the same time, in the north, uranium mining commenced in the late 1940s with the discovery of the Athabasca Basin. Additional mines were added including Beaverlodge (1953-1982), Rabbit Lake (1975-), Cluff Lake (1980-2003), Key Lake (1983-2001), McClean Lake (1999 – present), McArthur River (2000-), Cigar Lake (2005-)(Bratt 2012).

In 1965 electricity was generated from hydro electricity (201 MW), lignite coal (200MW), and powder coal, bunker oil, diesel and natural gas (250MW)(White 1976). Thereafter in the 1970s coal entered the STR as a replacement technology. Although the first lignite coal -power generating plant opened in 1959 with 66MW, it was the 1970s that the significant commitment was made to the deployment of large lignite power plants and replacement of widely dispersed diesel and small generators (SaskPower n.d.). In 1971 a survey of lignite coal deposits in southern Saskatchewan confirmed the availability of substantial reserves of this fuel for power production purposes (Rediger 2004).

These alliances eventually created the necessary links and knots that consolidated coal power production. In 1967 the Coteau Creek generating station was brought on with 187,500 kilowatts and two additional 150,000 kilowatt-hours were added to Boundary Dam in 1969 and 1970, and 100,000 kw h to the Queen Elizabeth, and 150,000 to Boundary Dam in 1973. In the 1970s an increasing rate of inflation and an international energy crisis occurred (White 1976). In the 1970s Boundary Dam was expanded by 690 MW marking the beginning of an era of coal expansion

(562 MWs in the 1980s and 279 in 1992). By 1991, 70% of SaskPower's electricity was generated by burning coal (SaskPower 2010).

Links and knots creating the coal actant were facilitated by endogenous and exogenous events. One endogenous and two exogenous events contributed to the development of coal in power production in Saskatchewan. The endogenous event was the decision not to develop hydro electricity. In 1978 one hydro project was formally rejected and another delayed until 1985 (Abouguendia et al. 1980). Two boards of inquiry were established in 1977 to review SPC's plans to build a dam for hydroelectric plant at Wintego Rapids on the Churchill River, as well as an extension to the Poplar River Power Station at Coronach and a new hydro plant near Nipawin. Two boards announced their findings the following year. The first concluded SPC not proceed with the Churchill project and the second stated that subject to certain conditions SaskPower should proceed with the Poplar River expansion and the plant at Nipawin. More detailed economic feasibility was required at Nipawin and SaskPower had to implement land management procedures and mined land reclamation plans and adopt safeguards for water (Rediger 2004).

The two exogenous events were the availability of capital to expand power plants in a pro-government spending era and the culture of government service provision in Saskatchewan (the birth place of universal healthcare)(Rediger 2004). By the 1990s, however, financial risk and government deficits became paramount concern drying up government credit and stymying large power plant and infrastructure development. Electrical deregulation in the United States lead to competitions, downsizing, cost-cutting, and performance improvement (SaskPower 1995). Environmental concerns over air quality emerged. The public became involved in consultations over developments impacting the environment. The 1990s saw a plethora of reports, and a government review panel (SaskPower 1995).

Eyeing developments to the south, and on the Alberta border, the Conservative Party of Saskatchewan, headed by Grant Devine in the 1980s considered privatization. In preparation SaskPower let go almost one third of its staff and spun its natural gas operations off to a separate entity, SaskEnergy (SaskPower 1995). However, partly over the privatization issue, the NDP returned to power. In this epoch the dominant actor SaskPower emerged as the Crown Corporation in charge of power production and distribution and the dominant actant, coal.

The future of coal

The writing that the end of coal is coming is clear. However, Saskatchewan steadfastly holds onto King coal; the first commercial scale carbon capture and storage post combustion power plant was build in Saskatchewan (Fleece 2015). Alliances, knots and links of ANT are still strong. Saskatchewan continues to endorse CCS as part of its climate change strategy (GS 2017). It is clear that the future of coal is problematic, but stronger in Saskatchewan than many other developed countries. To transition from coal, and to embrace a new STR, the actant of coal, the alliance of the actors exposed by ANT must be considered. Can these actors transition to a new STR? Saskatchewan does have a plan to add over 1,800 MW of wind generation and 60MW of ground mounted solar photovoltaic generation to achieve 50% of renewables in its

power generation fleet (LAS 2015b). The fate of Saskatchewan's remaining coal plants and whether they will be retrofitted with CCS or shut down is unclear.

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