# Detailed Frameworks for Governing Infrastructure as Commons at the Bioregional Scale

## I. The Institutional Foundation: Reclaiming Infrastructure as Common-Pool Resources (CPRs)

The governance of vital infrastructure—including energy, water, digital, and transport networks—is currently constrained by a traditional, binary approach that often fails to deliver universal access, equity, and long-term ecological sustainability. Modern infrastructure systems are characterized by institutional and technological fragmentation alongside the globalization of their networks, demanding fundamentally new governance models.1 To bridge the critical meso-scale gap between municipal action and planetary policy, an alternative framework is required, founded upon the principles of infrastructure as a Common-Pool Resource (CPR).

### A. The Failure of Market/State Dichotomies in Infrastructure Governance

Conventional governance often frames infrastructure solely through the lens of a "market" or "state" dichotomy: either fully state-administered public utilities or services delivered by privately owned, profit-driven entities.2 This binary model is demonstrably inadequate for managing complex, interdependent systems at the regional scale.

The critique of the privatization model, frequently manifesting through Public-Private Partnerships (PPPs), is substantial. While PPPs aim to merge public oversight with private finance and expertise, they prioritize maximizing financial profit.3 This narrow focus invariably sidelines broader social goals, leading to systemic harms. Private control of infrastructure systematically disadvantages marginalized communities, exacerbating existing economic chasms.4 Furthermore, the profit mandate often compromises labor standards, leading to dampened labor power, limitations on wages, and a failure to prioritize job quality or worker training.4 This necessitates a robust "third way" of regulation that incorporates localized initiatives and substantial civil society involvement, moving beyond the market/state binary.1

### B. The CPR Paradigm: Applying Ostrom’s Design Principles to Infrastructure Systems

Elinor Ostrom's research demonstrates that common-pool resources, when governed by common property protocols—arrangements distinct from private ownership or state control—can be managed sustainably through local community self-management.6 Shared infrastructures, such as regional water systems, aggregated digital networks, or shared distribution logistics, exhibit the characteristics of CPRs, where a multitude of users can lead to overuse and resource degradation if collective responsibility is not established.1

Ostrom identified eight prerequisites for stable and long-enduring CPR institutions. These principles form the blueprint for designing effective Bioregional Commons governance:

1. **Clearly Defined Boundaries:** The resource being managed must have unambiguous boundaries, ensuring all appropriators (users) understand who belongs to the community and what specific assets are under governance (e.g., a legally defined watershed area or a specific fiber-optic service territory).6
2. **Congruence:** The rules governing the appropriation (use) and provision (maintenance, investment) of the resource must align directly with local environmental and social conditions.6 For example, water rules must adapt to seasonal flows, and energy rules must reflect local renewable capacity.
3. **Collective-Choice Arrangements:** Most appropriators must be allowed to participate in the decision-making process, ensuring the rules reflect the needs of the community rather than just expert or centralized authority.6
4. **Effective Monitoring:** Accountability requires robust monitoring systems, where monitors are either part of the user community or directly accountable to them.6
5. **Graduated Sanctions:** Penalties for rule non-compliance must be graduated—starting small and increasing—to maintain community rules without relying on overly punitive external enforcement.6
6. **Conflict-Resolution Mechanisms:** Systems must be cheap and easily accessible for rapidly resolving disputes among appropriators, acknowledging that conflicts are inevitable in shared management.6
7. **Minimal Recognition of Rights:** The rights of the local resource system must be acknowledged by external governmental authorities.
8. **Nested Enterprises:** For large systems (like bioregions), governance must be organized in multiple layers of nested institutions (discussed further below).

A critical extension of Ostrom’s original framework is necessitated by the technical complexity and dynamic nature of modern infrastructure. Beyond the classic institutional design principles, successful management of complex socio-technical CPRs requires two high-level operational capabilities: the constant provision of accurate and relevant information, particularly timely scientific knowledge for both managers and users; and the provision of infrastructure that is intrinsically flexible over time, allowing for continuous adaptation to changing conditions and resource links.6 The integrated management of modern systems like smart grids or regional digital networks relies heavily on these adaptive capabilities.

### C. Polycentric Governance: Designing Nested Institutional Arrangements for Scale

The Bioregional Commons framework inherently demands a polycentric approach to governance. A polycentric system is defined by multiple independent centers of decision making that interact through coordination, cooperation, competition, and conflict across various functional and jurisdictional domains.2

To design governance across the meso-scale, it is crucial to distinguish between *scale* and *level*.8 **Scale** refers to the spatial, temporal, or quantitative dimensions used to measure a phenomenon (e.g., the size of a watershed). **Level** refers to the units of analysis or jurisdictional position (e.g., municipal, state, federal).8 Bioregional governance operates at the meso-scale (an ecologically defined scale) but must manage interactions among pre-existing jurisdictional levels, which are often not neatly nested. The system must establish a "general system of rules" that enables polycentric interaction and collaboration among these diverse jurisdictional units, which may decide to work together for common purposes rather than strictly through formal jurisdictional leadership.7

## II. Establishing Bioregional Governance: The Meso-Scale Institutional Architecture

Effective Bioregional Commons governance requires formal institutional architecture capable of integrating ecological mandates, democratic participation, and existing legal frameworks across traditional political boundaries.

### A. Defining the Bioregional Boundary and Mandate

Unlike administrative boundaries, bioregions are defined by natural ecological limits, such as watersheds or ecoregions.9 This definition provides the optimal functional scale for managing interdependent resources like water, energy flows, and food systems. Bioregional organizations (such as Regenerate Hubs or Departments of Bioregion) promote this place-based philosophy as an alternative to models reliant on the nation-state and global supply chains.11 Their mandate includes defining the ecological carrying capacity of the ecoregion, building regional identity, and researching technologies appropriate for local conditions.11 The objective is to shift to a more self-sufficient, sustainable economy where the population is directly dependent on domestic production, incentivizing environmental stewardship.12

### B. The Bioregional Council/Trust Model: Composition, Representation, and Authority

The core governing body at the meso-scale is the Bioregional Council or Trust. For this body to possess necessary legitimacy and functional capacity, it must incorporate a plurality of perspectives.13

#### Pluralistic Representation and Non-Human Inclusion

A legitimate Bioregional Council must include representatives from diverse demographic, ethnic, and institutional groups, including human inhabitants, local and regional nonprofits, academic organizations, and public agencies with existing jurisdictional authority.13 Crucially, the Bioregional Council model moves beyond anthropocentric governance by embracing the bioregion itself—the watersheds, flora, fauna, and fungi—as a key partner and beneficiary.13 This requires establishing representatives, often ecological scientists or traditional stewards, to defend non-human interests within the decision-making structure.

#### The Role of Indigenous Sovereignty

Sustainable water and land management is highly dependent on power-sharing and the effective inclusion of Indigenous governance models. Indigenous Peoples assert sovereign rights to care for and manage lands and waters within traditional territories, a right enshrined in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, Article 26).14 As Indigenous Peoples gain power in water management, outcomes are expected to become increasingly sustainable, especially when land and water are managed integrally.15 The Council must formally incorporate this sovereignty, rather than merely treating Indigenous groups as advisory stakeholders.

#### Legitimacy Through State-Reinforced Self-Governance (SRSG)

The authority of a Council defined by ecological boundaries (rather than traditional political sovereignty) is established through nested polycentric systems. The legitimacy of the Council flows from two critical sources. First, power is rooted in the local community, where citizens participate directly in decision-making based on shared values.12 This is self-governance. Second, this local power must be formally reinforced by the surrounding state and federal "levels" through negotiated agreements.7 The establishment of a "general system of rules," such as a formal Memorandum of Agreement (MOA) among local governments and state/federal actors (as seen in the New York City Watershed arrangement), provides the necessary legal binding capacity for the non-sovereign entity to operate.7

The proposed composition and authority structure for the Bioregional Council is detailed below, illustrating the synthesis of democratic and jurisdictional mandates necessary for the meso-scale:

Table 1: Proposed Bioregional Council Composition and Authority

| **Stakeholder Category** | **Representation (Example Seats/Votes)** | **Core Mandate/Decision Authority** | **Source of Legitimacy** |
| --- | --- | --- | --- |
| Local/Municipal Governance | Representatives from nested local jurisdictions (mayors, council members).17 | Allocating shared resources; approving inter-municipal agreements; coordinating legal compliance.19 | Existing jurisdictional mandate; Inter-Municipal Agreements (IMA).18 |
| Community & Users | Representatives of resident groups, community organizations, and infrastructure users/customers.12 | Veto power on tariff changes; oversight of equity metrics (Universal Access); directing social goals.5 | Direct democratic participation; stakeholder representation model.16 |
| Ecological Stewards | Representatives of Indigenous communities, environmental NGOs, and ecological scientists.13 | Veto power on projects violating ecological carrying capacity; integrating ecological requirements (IWRM).20 | Bioregional principles; recognized rights of nature/Indigenous sovereignty.14 |
| Workers/Labor | Representatives of unions and workers in the infrastructure sectors.5 | Setting labor standards, green job creation metrics, and just transition planning.4 | Labor movement partnership; social justice mandate. |

### C. Legal Tools for Inter-Jurisdictional Cooperation

The legal foundation for the Bioregional Commons rests heavily on formal cooperation between existing political entities. Inter-Municipal Agreements (IMAs) are the primary legal mechanism to facilitate this meso-scale collaboration.18

IMAs allow participating municipalities to jointly or cooperatively perform activities, pool resources to achieve a mutual goal, or enter into a provider-recipient relationship where one participant delivers a service for others.18 These agreements are essential for governing shared infrastructure systems that cross town or county lines. Legally robust IMAs must specify detailed terms and conditions, including defining the services provided, establishing shared personnel and departments, clarifying communication protocols, and detailing the sharing of financial burdens, encompassing salaries, operating expenses, and capital costs incurred prior to and after the agreement date.17 This pooled resource structure allows the Bioregional Council to coordinate resource allocation and enforce accountability across the functional bioregion.19

## III. Framework I: The Water and Ecological Commons (The Foundational Meso-Scale Model)

Water governance provides the most mature model for applying the commons and bioregional philosophy, utilizing the watershed as the optimal scale for resource management.

### A. Integrated Water Resources Management (IWRM) as a Bioregional Operating Model

The Integrated Water Resources Management (IWRM) approach, often termed 'One Water,' is the global standard for governing water resources within an ecological context.22 IWRM promotes the coordinated management of water, land, and related resources to maximize social and economic welfare without compromising the sustainability of vital ecosystems.22 This approach recognizes that water is simultaneously an integral part of the ecosystem, a natural resource, and a social and economic good.22

The IWRM framework is essential because it addresses the inherent interdependencies of water use. For instance, pollution from agriculture reduces fresh water availability for drinking and industry, while mandated environmental flows necessary to protect ecosystems (like fisheries) reduce the volume available for crop irrigation.22 By focusing on the watershed scale, IWRM serves as a common reference unit for coordinating diverse policies and actions that affect the system, transcending narrow sectoral or jurisdictional views.10

### B. Governance Structures for Watershed Commons

Successful governance of major river systems demonstrates the viability of polycentric, cross-jurisdictional collaboration. The Rhine River system, managed by the International Commission for the Protection of the Rhine (ICPR), showcases a model where multiple countries coordinate on complex objectives, including improving water quality, implementing flood mitigation (Action Plan on Floods), maintaining habitat connectivity (Rhine habitat patch connectivity), and establishing continual biological monitoring.21 They utilize shared mechanisms, such as the Warning and Alarm Plan, to alert downstream users quickly during serious pollution events.21

The New York City Watershed arrangement provides a domestic example of a polycentric system created by a formal Memorandum of Agreement among dozens of local governments, environmental groups, and state/federal actors dedicated to safeguarding high-quality drinking water.7 This case highlights how a defined "general system of rules" (the MOA) can effectively enable sustained collaboration across multiple political entities.

Success in modern water governance relies fundamentally on shifting from reactionary crisis management to proactive, adaptive stewardship. Traditional approaches often rely on "reactionary decision making," implementing new regulations only in response to environmental crises such as pollution or major storm damage.24 IWRM and Ostrom’s monitoring principles demand a continuous, forward-looking strategy, like the Rhine’s multi-year programs for ecosystem restoration and flood protection.21 Achieving this proactive state requires sustained public education and the cultivation of public trust in the capacity of the watershed management groups, ensuring stability and long-term participation.24

### C. Data Sovereignty and the Watershed Data Trust

For effective monitoring and adaptive management—fulfilling Ostrom’s requirement for accurate, timely information 6—water governance must incorporate structures for managing data as a commons. Watershed Data Trusts are formal legal and governance structures that manage water-related data on behalf of a collective, such as a community or ecosystem.25

These trusts ensure responsible data collection, secure storage, and transparent utilization for informed decision-making within the watershed.25 Crucially, they protect privacy and uphold community interests, formalizing the legal terms under which sensitive ecological or usage data is shared and analyzed.

### D. Transition Strategy: Remunicipalisation of Water Systems

Achieving water as a human right 26 often necessitates reversing previous privatization. The remunicipalisation movement involves returning control of water services from private firms back to public (municipal or regional) administration, as seen in cases like Berlin, Paris, and Barcelona.27 Rationales for remunicipalisation span a broad political spectrum, including pragmatic motives like seeking cost savings, social-democratic goals of equitable distribution, and anti-capitalist efforts seeking non-commodified resource delivery.27

The transition is institutionally complex, requiring careful navigation of legal obstacles. These challenges typically revolve around the transfer of workers' rights, entitlements (such as pensions and seniority), and differing collective agreements between the private and public sectors.29 Post-transition, the organizational structure of the publicly owned utility must be determined. Utilities organized under public (administrative) law often experience direct political influence and low managerial autonomy, while those organized under private law structures, though still municipally owned, may resemble private-sector firms but offer greater managerial flexibility.30

## IV. Framework II: The Decentralized Energy Commons (Resilience and Equity)

The transition to a decentralized, renewable energy system requires institutional reforms that align utility incentives with ecological and social goals, fostering local ownership and enhancing resilience.

### A. Decoupling Regulatory Policy: Aligning Incentives

Traditional utility regulation creates an inherent conflict: utility profits are derived from retail sales volume, creating a "throughput incentive" that financially disincentivizes the utility from supporting energy conservation, efficiency programs, and customer-side distributed generation (DG).31

**Decoupling** mechanisms are the regulatory solution to this conflict. Decoupling ensures that the utility can collect its approved revenue requirement regardless of annual sales volume deviation.32 This mechanism removes the financial harm associated with conservation, allowing the utility to embrace efficiency programs and DG without penalty, thereby aligning financial incentives with public policy goals, such as reduced emissions and the clean energy transition.31 Decoupling is implemented in many regulated and deregulated states, often on a revenue-per-customer basis.31 However, mechanisms must be implemented carefully; consistent bill surcharges or the public perception that decoupling is an "earnings guarantee" can undermine its legitimacy and foster public opposition.31

### B. Community Ownership Models: Cooperatives and Aggregation

Community ownership models are central to establishing the Energy Commons, ensuring local control and capital sourcing.

German energy co-operatives (*Energiegenossenschaften*) exemplify a successful, regionally oriented model for decentralized renewable electricity generation, collecting capital from individuals and fostering high local acceptance.34 While early success relied on favorable funding, sustained viability now requires adaptation, including the diversification of business fields (to include energy services and local general interest services) and cooperation at the regional level to achieve economies of scale and geographical diversification.34

Alternatively, **Community Choice Aggregation (CCA)** allows local governments to aggregate the demand of their residents and procure electricity on their behalf.35 CCAs empower local entities to rapidly shift to greener power resources, enabling local control over electricity generation aligned with regional economic and environmental goals, and expanding consumer choices.35 However, CCAs face challenges, including dependence on enabling state legislation, administrative costs, and potential push-back from incumbent utilities.35 Furthermore, CCAs require significant long-term procurement contracts, and financial constraints (such as credit difficulties resulting from market volatility) can hinder their ability to establish the favorable credit ratings necessary to secure capital at reasonable rates.36

### C. Infrastructure Resilience: Governing Community Microgrids and Islanding Capability

Resilience is a primary goal of the Energy Commons. Microgrids are defined by their ability to operate in grid-connected mode or autonomously in "island mode," disconnecting from the main grid during outages.37 This capability allows facilities connected to the microgrid to continue serving critical loads (e.g., hospitals, emergency services).37

Governing microgrids as a commons ensures that their significant resilience benefits extend tangibly to the local population.38 Community-owned microgrids empower local populations by fostering energy security, reducing greenhouse gas emissions through prioritized renewable energy integration, and creating local economic opportunities through the building and maintenance of these systems.38 Governance must involve managing the complex control systems that coordinate Distributed Energy Resources (DERs), balance electrical loads, and oversee the controlled disconnection and reconnection processes.37

### D. Implementing Energy Democracy: Social Justice and Labor

The governance of the energy system must be rooted in principles of energy democracy, ensuring a socially just transition. This demands universal access, fair prices, and the prioritization of social and environmental goals over pure profit motives.5

An ethical imperative exists to prioritize the needs of marginalized groups, including low-income families and indigenous communities, who are disproportionately affected by energy poverty and the proximity of fossil fuel production sites.5 A successful transition must explicitly include a "just transition" framework, involving unions and workers to ensure the creation of secure, unionized, and well-paid jobs in the renewable energy sector.5 Democratic control mechanisms, such as involving both users and employees on the boards of municipal energy companies, are critical preconditions for absolute transparency and accountability.5

## V. Framework III: The Digital and Data Commons (Connectivity and Knowledge)

Digital infrastructure is fundamental to modern society, serving as the "infrastructure of life".39 Governing it as a commons requires treating connectivity as a necessity and establishing institutional frameworks for data sovereignty.

### A. Digital Infrastructure as a Public Utility and Ethical Imperative

The pervasive integration of the internet into all aspects of civic and economic life transforms broadband access from a luxury service into an ethical necessity.39 Millions of citizens lack the resources to fully participate in the digital age, lagging behind European counterparts in terms of access and pricing.39 Therefore, treating broadband as a utility is considered the most effective policy path to remedy existing access inequalities.

However, this designation must be carefully balanced with the technical realities of digital service provision. Opponents argue that regulating broadband as a homogenized commodity risks invoking the "flaw of averages," resulting in an "averaged" service plan that fails to meet the highly variable, specialized demands of diverse consumers.40 A critical reconciliation is required: the utility classification must ensure universal access (the ethical requirement) while the institutional design of the Digital Commons must incorporate Ostrom’s principle of congruence.6 This means the governance structures must allow for the customization of appropriation and provision rules to match local user demands and technical conditions, preventing the imposition of a one-size-fits-all plan.40

### B. Governance Models for Public Broadband

Municipal fiber networks offer a robust governance model for the Digital Commons, providing an alternative to private, profit-driven service. The Chattanooga EPB fiber network demonstrates substantial realized economic value, generating billions in economic benefits over a decade through job creation, productivity gains, and increased access to telehealth services.41 Publicly owned networks are uniquely positioned to address unmet public interest needs, such as providing no- or low-cost services to schools and low-income households—entities often ignored by private ISPs due to hard profitability constraints.41

Successful deployment requires mandatory preliminary steps, including rigorous feasibility studies covering engineering, market research, cost estimation, and penetration projections.41 Municipalities may also mitigate initial financial risk by phasing deployment, perhaps by first building a core fiber backbone that connects key public facilities before developing a full Fiber-to-the-Home (FTTH) network.41

### C. Data Governance as a Commons: Implementing Data Trusts and Platform Cooperatives

The immense volume of data generated by digital infrastructure must be governed as a common resource to protect citizen interests and ensure its value is harnessed for collective benefit.

**Data Trusts** are critical legal and institutional structures for managing citizen data. Projects like the Barcelona DECODE initiative enable citizens to share granular personal data—data that could negatively impact housing prices or insurance premiums if accessed by private entities—for use in city planning and policymaking.43 The primary value of this governance structure lies in the debate it surfaces around data sovereignty and the terms of data sharing, allowing citizens to control the data they generate and ensuring transparency in its exploitation.43

Furthermore, the labor component of the digital economy requires a commons approach. **Platform Cooperativism** is an intellectual and institutional framework advocating for cooperatively owned, democratically governed businesses (platforms).45 Owned by workers, users, and other stakeholders, platform co-ops provide an alternative to extractive venture capital models, ensuring ethical commitments, fair working conditions, and promoting ecological and social sustainability.45

### D. Legislative Mechanisms for Universal Access and Digital Equity

Formal legislation is essential to mandate equitable access. The U.S. Infrastructure Investment and Jobs Act (IIJA) explicitly requires action to prevent and eliminate **digital discrimination** of access.46 This supports the long-standing universal service principles established by Congress, which aim to increase access for consumers in rural areas and for low-income consumers, ensuring that broadband is deployed to all Americans in a reasonable and timely fashion.46

## VI. Framework IV: The Regional Logistics and Supply Chain Commons (Transport and Food Systems)

Infrastructure governance must extend beyond utilities to include the regional logistics systems necessary for bioregional self-sufficiency and resilience, particularly relating to food supply.

### A. Defining Regional Logistics Infrastructure as a Commons

To achieve a bioregional economy less reliant on fragile global supply chains, local communities require a well-functioning food system infrastructure, including processing facilities, distribution networks, and support services for local agri-food entrepreneurs.12 Failure to address this need represents a major missed opportunity for economic development, job growth, and public health.47

Federal support programs, such as the Resilient Food Systems Infrastructure (RFSI), acknowledge this gap, focusing funds on building resilience in the "middle of the food supply chain" through support for equipment, value-added products, and coordination services for local and regional producers.48 Governing these distribution and processing assets as a commons ensures that they operate to maximize local benefit and sustainability rather than being solely profit-driven.

### B. Food Hubs: Cooperative Models for Aggregation and Value-Chain Facilitation

Food hubs are organizations or businesses that actively manage the aggregation, distribution, and marketing of source-identified food products, primarily from local and regional producers.49 They serve a vital function as sales channels for small to medium-scale farmers, providing transportation efficiency and crucial access to larger wholesale customers, such as institutions (schools, hospitals).49

Food hubs utilize cooperative and values-based approaches to distribution, acting as "value-chain facilitators" to ensure that benefits are equitably shared among all participants, including farmers, farmworkers, distributors, and consumers. Their typical governance structures ensure that operational decisions support the long-term health of the regional food system.

### C. Governing Land for the Commons: Agricultural Community Land Trusts (CLTs)

The land resources underpinning the logistics commons must be held under collective stewardship. Community Land Trusts (CLTs) are institutional models designed for locally controlled land use. Although often associated with affordable housing, the historical foundation of the CLT movement lies in protecting farmland (e.g., New Communities Inc.).51

CLTs manage land-based resources by separating the ownership of the land from the ownership of any property improvements, thereby maintaining affordability and ecological standards in perpetuity.51 Modern CLTs are expanding into urban agriculture and commercial development.51 Their governance structure requires representation not only from CLT homeowners but also from members who live in the service area but do not own CLT property, ensuring the institution responds to broad community needs.52

### D. Integrating Transport Networks into Bioregional Planning

Bioregional governance frameworks must integrate large-scale transport infrastructure—including roads, bridges, and energy transmission lines—into ecologically just planning.20 Investment in fixed installations necessary for political subdivision function, such as storm water infrastructure, roads, and airport infrastructure 53, must be coordinated by the Bioregional Council. The Council must ensure that these developments adhere to ecologically just practices and meet broader requirements for climate adaptation and ecosystem protection, avoiding the degradation caused by extractive industries.20

## VII. Financial and Implementation Architecture for the Commons

Transitioning infrastructure to a commons model requires a fundamental shift in financing mechanisms, moving away from short-term, profit-driven capital toward patient capital and solidarity finance structures.

### A. Patient Capital and Solidarity Finance Mechanisms

Infrastructure governed as a commons requires **patient capital**—stable, long-term investment focused on achieving social and environmental returns, rather than maximizing short-term financial profit.54

Traditional private equity funds operate on a drawdown model, calling for capital over a short period and aiming for high returns on invested capital, often experiencing a J-curve effect (low initial performance).55 By contrast, **Evergreen** (open-end) funds offer continuous capital inflows and remain perpetually open, mitigating the J-curve and providing immediate exposure to diverse, long-term investments. This evergreen structure is inherently aligned with the perpetual stewardship mandate of infrastructure commons.55

**Solidarity finance**, encompassing cooperative financial institutions (like credit unions and cooperative banks) and community-based funds, has a long history of serving community needs and providing capital to collective enterprises.56 These models provide "embedded finance," prioritizing community benefit and stability over high-risk financial speculation.

### B. Public Banking Models for Infrastructure Investment

Public banking offers a critical financial mechanism that insulates infrastructure development from private market volatility and aligns capital deployment directly with socio-economic and bioregional mandates. Public banks pursue economical, structural, and socio-economic goals.57

The Bank of North Dakota (BND) provides a concrete model. The BND operates numerous low-interest loan funds (including the Infrastructure Revolving Loan Fund and the Legacy Infrastructure Loan Fund) designed to finance capital construction projects for political subdivisions.58 These funds cover a vast range of critical infrastructure, including water treatment plants, sewerlines, road infrastructure, electricity transmission, and communications networks.53

By providing the primary source of patient capital for regional infrastructure, public banks become powerful mechanisms for enforcing CPR principles. They can embed specific compliance metrics—such as adherence to IWRM standards, mandatory equity provisions (universal access), or green job creation goals—directly into loan agreements. If a local jurisdiction fails to meet its commons governance responsibilities, the public bank can leverage financial pressure to enforce adaptive policy changes, acting as an effective, mission-aligned external monitor and sanctioning agent.6

### C. Community Bonds and Impact Investing

Community bonds provide a direct path for collective financing, allowing organizations to raise short-term liquidity by selling low-interest bonds directly to community activists and members who are committed to the project’s long-term social viability.54

Social Impact Bonds (SIBs), which involve private investors funding upfront costs with the government paying a return if predetermined outcomes are met 59, require cautious application in the commons framework. While SIBs can fund socially determined health (SDH) interventions and incorporate racial and health equity impact measures 60, they carry significant risks identified in health literature: they can increase costs to governments, restrict program scope, fragment policymaking, and risk undermining public sector services by applying quantitative, market-oriented metrics.59 If used, SIB design must incorporate community participatory approaches to ensure they prioritize large health equity impacts over simple financial returns.60

A comparison of key financial models highlights the structural differences required for commons stewardship:

Table 2: Comparative Financial Models for Infrastructure Transition

| **Model** | **Primary Funding Source** | **Risk Profile/Ownership** | **Alignment with Commons Goals (Equity/Resilience)** | **Structural Goal** |
| --- | --- | --- | --- | --- |
| **Private/PPP** | Private equity, institutional debt.3 | High profit drive, external control, cost-skimping.4 | Low; focus is maximizing financial returns over perpetual stewardship. | Extractive, Finite Return |
| **State/Municipal (Traditional)** | Public tax revenue, municipal bonds. | Centralized control, efficiency challenges, susceptible to political cycles. | Moderate; requires strong policy mandates (remunicipalisation).30 | Centralized Service Provision |
| **Solidarity Finance/Co-op** | Patient capital, community bonds, member equity.54 | Distributed risk, focus on long-term systemic stability and social return. | High; governance tied directly to user/community interest and non-profit mandate.34 | Perpetual Stewardship, Local Benefit |
| **Public Banking** | State/Legacy Funds, recycled loan capital.58 | Low-interest, patient finance; insulates funding from private market volatility. | High; enables funding for critical projects with low private returns (e.g., resilience, universal access).53 | Counter-Cyclical, Mission-Driven Finance |

### D. Policy Recommendations for Enabling Bioregional Commons (Regulatory and Legal Reform)

The establishment of the Bioregional Commons requires targeted regulatory and legal reforms at the state level:

1. **Mandate Inter-Municipal Cooperation:** State legislation must incentivize and provide clear legal structures (Article 5-G or similar) for political subdivisions to enter into Inter-Municipal Agreements (IMAs) for resource pooling and joint infrastructure operation across bioregional boundaries.17
2. **Adopt Revenue Decoupling:** Utility regulators should be mandated to adopt full revenue-per-customer decoupling policies to eliminate the throughput incentive, aligning utility financial stability with public goals for energy conservation and distributed generation investment.31
3. **Formalize Data Trust Governance:** Legal frameworks must be established for the creation and operation of Watershed and Digital Data Trusts, defining citizen data sovereignty rights and organizational maturity requirements necessary for managing complex, granular data as a common resource.25
4. **Expand Public Finance Capacity:** State governments must invest in or establish public banking institutions capable of providing long-term, low-interest patient capital specifically dedicated to financing resilient, community-owned infrastructure projects that align with the Bioregional Council's mandates.58

## VIII. Synthesis and Conclusion: A Blueprint for Polycentric Resilience

The Bioregional Commons framework successfully addresses the meso-scale governance gap by replacing fragmented, profit-driven infrastructure provision with integrated, ecologically congruent stewardship. The polycentric structure, anchored by the Bioregional Council and reinforced by legal mechanisms like IMAs and public finance, provides the institutional resilience necessary for long-term sustainability.

### A. Cross-Sectoral Integration: The Bioregional Ecosystem

The four frameworks are interdependent and must be governed cohesively:

* **The Energy-Water Nexus:** IWRM (Water) mandates coordination with microgrid development (Energy) to ensure that energy planning (e.g., cooling demands, environmental flows for hydropower) does not compromise ecosystem sustainability.22
* **The Digital-Governance Nexus:** The Digital Commons, particularly through municipal fiber networks and Data Trusts, provides the real-time monitoring and secure information architecture required for adaptive management in both the Water and Energy sectors, fulfilling Ostrom’s crucial need for timely, accurate knowledge.6
* **Logistics and Land Use:** Integrating Food Hubs and Agricultural CLTs ensures that regional logistics and food production support localized economic self-sufficiency, aligning transport and land-use decisions with the ecological carrying capacity defined by the Bioregional Council.12

### B. Validation Against Ostrom’s CPR Principles at the Bioregional Scale

The integrated governance model confirms its institutional viability by satisfying Ostrom's design principles:

* **Boundaries & Congruence:** Defined by ecological watersheds (Water) and service areas (Energy/Digital), with rules adapted via Decoupling and IWRM (Congruence).6
* **Collective Choice & Monitoring:** Ensured through the Bioregional Council’s pluralistic representation (users, workers, ecologists) and Watershed/Digital Data Trusts (Monitoring).13
* **Sanctions & Conflict Resolution:** Provided by graduated rules set by the Council and enforced through mechanisms like public banking loan terms, combined with accessible IMAs and governance protocols (Conflict Resolution).6
* **Nested Enterprises:** Achieved by formally linking local jurisdictions via Inter-Municipal Agreements and State-Reinforced Self-Governance (SRSG) structures to the overarching Bioregional Council.7

### C. Conclusion: Bridging the Scale Gap

The application of the CPR paradigm and polycentric governance theory at the bioregional scale constructs a durable institutional architecture. This structure empowers local democratic participation and aligns economic activity with ecological realities, addressing systemic challenges that transcend arbitrary political boundaries. By formalizing infrastructure ownership as a perpetual commons, facilitated by patient public finance and integrated sectoral management, the framework shifts infrastructure governance from a system dominated by profit extraction and administrative fragmentation to one focused on long-term resilience, equity, and holistic ecological stewardship.

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