Co-production in distributed generation: Renewable energy and creating space for fitting infrastructure within landscapes – Appendix

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In this appendix all literature is listed, that has been used for the assessment of landscape impact and co-production of spatial decision on implementation of DGRS infrastructure, distributed generation of renewable energy systems. These are all academic sources used for the review.[136]

This review describes the infrastructural elements of the socio-technical system of power supply based on renewables and the role of landscape concerns in decision-making for establishing renewable energy in emerging 'intelligent grids'. The considerable land areas required for energy infrastructure, call for large amounts of 'distributed generation' close to energy consumption. Securing community acceptance of renewables' infrastructure, perceived impacts on the community, and 'landscape justice' require two types of co-production: in power supply, and in making space available.

With coproduction landscape issues are prominent, for some options even dominant. However, 'objectification' of landscape, e.g. the use of 'visibility' as proxy for 'visual impact', is part of lingering centralized and hierarchical approaches to renewables' deployment. For achieving 'distributed generation', institutional tendencies of centralization and hierarchy, in power supply management as well as in siting, should be replaced by coproduction. Renewable energy is a natural resource, and for studying coproduction common pool resources theory is highly relevant. Coproduction is the key to respecting landscape values, furthering justice, and achieving community acceptance.

The reference list of this review paper only contains references that have been used in the text. All qualifications as are published in *Landscape Research* in table1 and table 2 [136], are based upon a much longer list. These references are given in this appendix; all have been indicated at their most relevant place in the tables below.

Table 1. Distributed Generation, options for co-production, spatial claims and landscape-issues.

Type of infrastructure *3*	**Size (capacity)**	**Relevance for co-production/participation** *3*	**Spatial claims (amount / type)** *12,96.*	**Landscape *relevance* / type** *99*
Combustion turbine CHP (pref. biomass/ biofuel) *45,62,129*	1–250MW	Single owner / co-operative / or central	*Small* / Spot / Large / crops *87*	*Low* Visual impact; Ecology crop cult.
Micro-CHP (combustion; pref. biofuel) *70,129*	35 kW–1MW	Single owner / co-operative / *111*	*Moderate* / Spots; Larger numbers/ crops *87*	*Low* Visual impact; Ecology crop cult.
Biomass, e.g. gasification *56*	100 kW–20MW	Co-operative / Possibly single owner	*Large* (crops) / Areas for growing crops *87*	*High* Ecology crop cultivation
Stirling engine (micro CHP; pref. biofuel) *4*	2–10kW	Single owner *4,111*	*None*	*None* Ecology: fuel
Small hydro *29*	1–100MW	Possibly co-operative/ shareholders *9*	*Substantial* basin, *72,78*	*Substantial* Ecology river *119*
Micro hydro	25 kW–1MW	Co-operative / Single owner *9,29*	*Small*	*Low* Ecology stream *119*
Wind farm onshore / near shore *19, 33,42*	5-500MW	Possibly co-operative / shareholder *14, 134*	*Moderate* / Area combined use*50,127,131,136*	*High* Visual impact / *8,38,64,89,93, 121,130*
Off-shore wind farm *44, 55*	20-1000MW	Possibly co-operative / shareholder	*Huge* / Wide area sailing prohibited *103*	*High* / Ecology / possibly positive *132*
PV panels, crystalline / silicone based	20 Watt–10 kW	Single owner / co-operative *57,77, 113,115,124*	*Moderate* / Large numbers; Combined use *70,*	*Moderate* /Visual impact / Ecology when sited on soil *2*
PV arrays / silicone or perovskite based *49,118*	20 kW–100 kW	Single owner / co-operative *2,32,57,90,124*	*Moderate* / Large numbers; Combined *90*	*Moderate* / Visual impact / Ecology when sited on soil *92*
PV plants / panels based / ground based *30,98*	1-500MW	Central; possibly co-operative or shareholder *32,36,113,*	*Large* / Large areas; hard to combine *26,35*	*High* / Visual impact / Ecology soil *30, 36,43,92,114*
Solar central thermal receiver (mirror based) *17*	1–10MW	Central; possibly co-operative or shareholders	*Large* / Large area; hard to combine *108,110*	*Substantial* / Visual impact / Ecology: soil
Fuel cells, phosacid / molten / etc. *39,59, 86* (also table 2)	200 kW–5 MW	Single owner / co-operative / shareholder *139,142*	*Small* Spot; vehicles	*Low* / Visual impact
Fuel cells, proton exchange (also table 2: H_2) *59,97,141*	1 kW–250kW	Single owner / co-operative	*Small* Spot; indoor; vehicles	*None*

Type of infrastructure *3*	**Size (capacity)**	**Relevance for co-production/participation** *3*	**Spatial claims (amount / type)** *12,96.*	**Landscape *relevance* / type** *99*
Geothermal *18,54*	5–100MW	Single owner / co-operative / shareholder *5, 47, 109*	*Moderate* Spot; track (pipe) *27,101,105,107*	*Low* / Visual impact *120*
Marine energy: *16,34,61,73,100*				
Waves	500kW-50MW	Co-operative / shareholder	*Moderate* Island; coastal *6, 11,16,20,34,88,136*	*Moderate* Ecology shallows
Tidal flows *41,82*	200 kW–250MW	Co-operative / shareholder *135*	*Moderate* Estuary / bay *6,34,16,20,81*	*Substantial* Ecology estuaries *34,61*
Wind turbines off-shore/near shore *55,102*	200 Watt–5MW	Private and/or co-operative /shareholder	*Small*; combined with mariculture *51,73,136*	*Substantial* Visual impact / Ecology: birds,bats *79,61,100,132*
Saline'fresh water gradient: Reverse Electr. Dialysis *16,65*	100 kW-5MW	Co-operative / shareholder *48*	*Moderate* Mainly estuary *73*	*Substantial* Ecology estuaries *20, 61,100*
Saline gradient: Osmotic Pressure *16,65*	4 kW-50MW	Co-operative / shareholder	*Moderate* Mainly estuary *20*	*Substantial* Ecology estuaries,*61*
Seawater cooling (saving power for Airco)	4MW-50MW	Co-operative / shareholder	*Moderate* Coastal / Islands *84*	*Low* Deep coastal water
Ocean Thermal Energy conversion *16,94,128*	50kW-50MW	Co-operative / shareholder	*Small* Islands *84,94*	*Low* Ecology *20,100*

Table 2. Spatial claims, options for co-production and issues of landscape values of other intelligent grid infrastructures.

Type of infrastructure	**Size (capacity)**	**Relevance for co-production and participation**	**Spatial claims (amount / type)** *63*	**Landscape *relevance* / type**
Distributed Storage *21,95*				
Heat storage (electric boilers)	1-4kW	Single owner *10*	*None* indoor	*None*
Heat stored buildings (solar, electric heat pumps) *77,80,116*	10-500kW	Single owner / co-operative *10,22,52*	*Low* Resource rights passive solar	*Low* Orientation sun, planning design
'Cold' storage (cooling systems) *52*	1-100 kW	Single owner *52*	*None* Indoor	*None*
Battery storage *15,23,60,76,86*	500 kW–5 MW	Single owner / co-operative *124*	*Small* Indoor or spot	*Low* Visual *Moderate* waste *86*

Type of infrastructure	**Size (capacity)**	**Relevance for co-production and participation**	**Spatial claims (amount / type)** *63*	**Landscape *relevance* / type**
Electrolizer/ Fuel cell hydrogen storage *23,97,106*	50-1kW	Single owner *46,139*	*Small* Indoor or spot	*None*
Electric vehicles (Vehicle-to-grid) *85,123*	10-100 kW	Single owner / private cars /co-owned *7,58*	*Very small* Recharging points possible indoor	*None*
Electric vehicles public transport; freight *7,85*	10-100 kW	Public / private / co-operative	*Small* Recharging points possible indoor	*None*
Storage Renewable Energy in non heat consumption				
Neighborhood Water systems	10kW-1000kW	Co-operative / public / shareholder	*Moderate* Level in basins / groundwater level *72*	*Low* ecology groundwater
Pumped hydro (high altitude water basins) *76,78*	1MW-1000MW	Centralized *24,53,71*	*Large* Land use change as with large hydro *28*	*High* Ecology; abandon functions like Agriculture
Desalinization: reservoirs *5,40*	10kW-50 MW	Co-operative / shareholder / public	*Moderate* plant; basin *5*	*Low* visual
Transmission of RES generated power				
HVAC Transmission *68*	10-150kV	Public / private /centralized *13,112,126*	*Large* Track in open air *31,75,104,117*	*High* Ecology (mod.) Visual impact *1,37,83,138*
Super Conducting HVDC Transmission *66*	100-1000 kV	Public / private / shareholder	*Small* Narrow track underground *122*	*Low* Ecology underground *122*
Low voltage grid (DC) *25,67,69*	20-100V	Co-operative / household *29,69,91, 125,133.*	*Small* Indoor / Undergound	*None*
Low voltage grid (AC) *69*	220V-25kV	Public / co-operative *125*	*Small* Indoor / Underground *133*	*Low* Visual in case of in open air

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